Adept Cobra ePLC600 & ePLC800 Robot

User's Guide

adept®

Adept Cobra ePLC600 & ePLC800 Robot

User's Guide

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Chapter 1: Introduction

1.1 Product Description

Adept Cobra ePLC600/ePLC800™ Robots

The Adept Cobra ePLC600 Robot and Adept Cobra ePLC800 Robot are four-axis SCARA robots (Selective Compliance Assembly Robot Arm). See the following two figures. Joints 1, 2, and 4 are rotational; Joint 3 is translational. For a description of the robot joint locations, see Robot Joint Motions on page 10.

The Adept Cobra ePLC600/800 robots require a user-supplied PLC for motion control. The robots are programmed and controlled using the PLC. Mechanical specifications for the Adept Cobra ePLC600/800 robots are provided in Technical Specifications on page 83.

NOTE: The descriptions and instructions in this manual apply to both the Adept Cobra ePLC600 Robot and the Adept Cobra ePLC800 Robot, except for instances where there is a difference, as in dimension and work envelope drawings. In those cases the information is presented for both robots.

Figure 1-1. Adept Cobra ePLC800 Robot

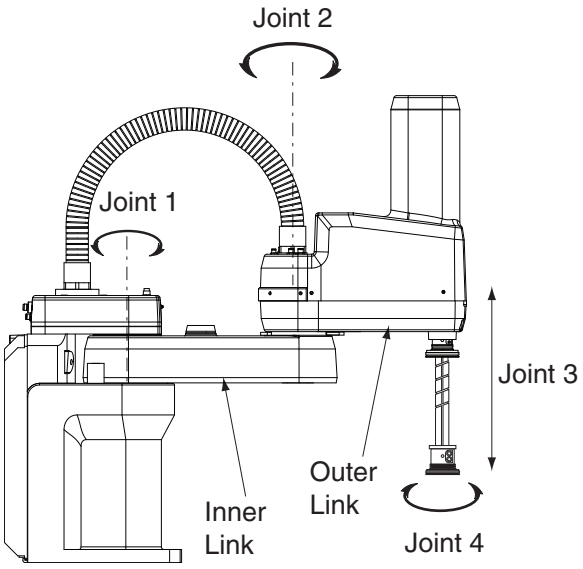


Figure 1-2. Robot Joint Motions

eAIB™ (Amplifiers in Base)

The amplifiers for the Adept Cobra ePLC600/800 robots are embedded in the base of the robot.

The Adept eAIB features:

- On-board digital I/O
- Low EMI for use with noise sensitive equipment
- No external fan for quiet robot operation
- 8 kHz servo rate to deliver low positional errors and superior path following
- Sine wave commutation to lower cogging torque and improve path following
- Digital feed forward design to maximize efficiency, torque, and velocity
- Temperature sensors on all amplifiers and motors for maximum reliability and easy troubleshooting
- Hardware-based E-Stop and Teach Restrict controls

  These are for improved safety relative to European standards implemented in 2012.

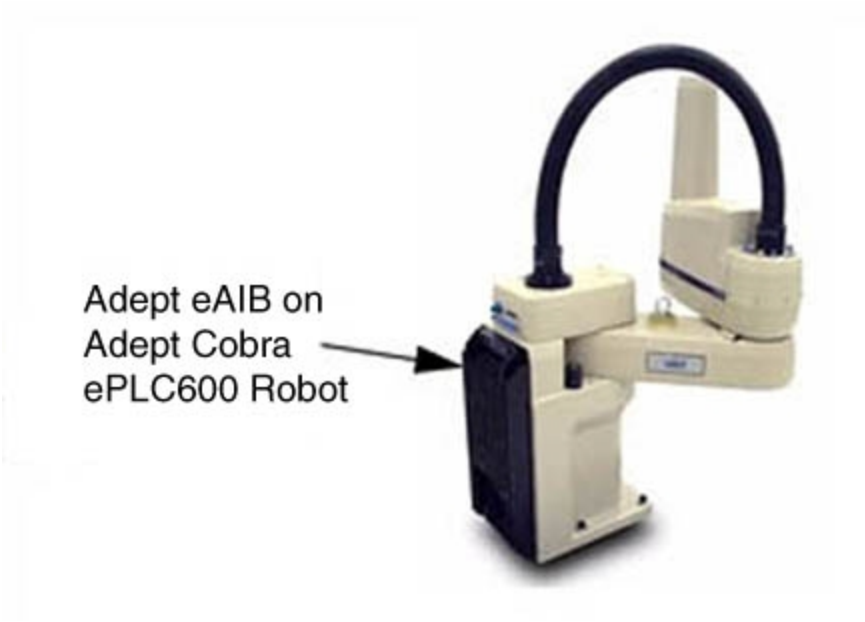


Figure 1-3. Amplifier on Robot, ePLC600 Shown

1.2 Dangers, Warnings, Cautions, and Notes

There are six levels of special alert notation used in Adept manuals. In descending order of importance, they are:

DANGER: This indicates an imminently hazardous electrical situation which, if not avoided, will result in death or serious injury.

DANGER: This indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING: This indicates a potentially hazardous electrical situation which, if not avoided, could result in injury or major damage to the equipment.

WARNING: This indicates a potentially hazardous situation which, if not avoided, could result in injury or major damage to the equipment.

CAUTION: This indicates a situation which, if not avoided, could result in damage to the equipment.

NOTE: Notes provide supplementary information, emphasize a point or procedure, or give a tip for easier operation.

1.3 Safety Precautions

DANGER: Adept Cobra ePLC600/800 robots can cause serious injury or death, or damage to themselves and other equipment, if the following safety precautions are not observed.

- All personnel who install, operate, teach, program, or maintain the system must read this guide, read the *Adept Robot Safety Guide*, and complete a training course for their responsibilities in regard to the robot.
- All personnel who design the robot system must read this guide, read the *Adept Robot Safety Guide*, and must comply with all local and national safety regulations for the location in which the robot is installed.
- The robot system must not be used for purposes other than described in Intended Use of the Robots on page 13. Contact Adept if you are not sure of the suitability for your application.
- The user is responsible for providing safety barriers around the robot to prevent anyone from accidentally coming into contact with the robot when it is in motion.
- Power to the robot and its power supply must be locked out and tagged out before any maintenance is performed.

1.4 What to Do in an Emergency Situation

Press any E-Stop button (a red push-button on a yellow background/field) and then follow the internal procedures of your company or organization for an emergency situation. If a fire occurs, use CO_2 to extinguish the fire.

1.5 Additional Safety Information

Adept provides other sources for more safety information:

Manufacturer's Declaration of Conformity (MDOC)

This lists all standards with which each robot complies. For details, see Manufacturer's Declaration on page 14.

Adept Robot Safety Guide

The *Adept Robot Safety Guide* provides detailed information on safety for Adept robots. It also gives resources for more information on relevant standards.

It ships with each robot manual, and is also available from the Adept Document Library. For details, see Adept Document Library on page 15.

1.6 Intended Use of the Robots

The Adept Cobra ePLC600/800 robots are intended for use in parts assembly and material handling for payloads less than 5.5 kg (12.1 lb). See for complete information on the robot specifications. Refer to the *Adept Robot Safety Guide* for details on the intended use of Adept robots.

1.7 Installation Overview

The system installation process is summarized in the following table. Also, refer to Robot Installation on page 17 and System Installation on page 23.

> **NOTE:** For dual-robot installations, see the Adept Dual-Robot Configuration Procedure, which is available in the Adept Document Library.

Table 1-1. Installation Overview

Task to be Performed	Reference Location
Mount the robot on a flat, secure mounting surface.	See Mounting the Robot on page 19.
Install the Front Panel, and pendant, if purchased.	See Description of Connectors on Robot Interface Panel on page 21.
Create a 24 VDC cable and connect it between the robot and the user-supplied 24 VDC power supply.	See Procedure for Creating 24 VDC Cable on page 26.
Create a 200-240 VAC cable and connect it between the robot and the facility AC power source.	See Creating the 200-240 VAC Cable on page 29.
Install user-supplied safety barriers in the workcell.	See Installing User-Supplied Safety Equipment on page 37.
Learn about connecting digital I/O through the XIO connector on the robot.	See Using Digital I/O on Robot XIO Connector on page 43.
Learn about starting the system for the first time.	See Starting the System for the First Time on page 50.
Learn about installing optional equipment, including end-effectors, user air and electrical lines, external equipment, solenoids, etc.	See Installing End-Effectors on page 69.

1.8 Manufacturer's Declaration

The Manufacturer's Declaration of Incorporation and Conformity for Adept robot systems can be found on the Adept website, in the Download Center of the Support section.

http://www.adept.com/support/downloads/file-search

NOTE: The Download Center requires that you are logged in for access. If you are not logged in, you will be redirected to the Adept website Login page.

1. From the Download Types drop-down list, select Manufacturer Declarations
2. From the Product drop-down list, select your Adept robot product category (Adept Cobra Robots).
3. Click Begin Search. The list of available documents is shown in the Search Results area, which opens at the bottom of the page. You may need to scroll down to see it.
4. Use the Description column to locate the document for your Adept robot, and then click the corresponding Download ID number to access the Download Details page.
5. On the Download Details page, click Download to open or save the file.

1.9 How Can I Get Help?

Refer to the *How to Get Help Resource Guide* (Adept P/N 00961-00700) for details on getting assistance with your Adept software and hardware. Additionally, you can access information sources on Adept's corporate website:

http://www.adept.com

- For Contact information:
  http://www.adept.com/contact/americas
- For Product Support information:
  http://www.adept.com/support/service-and-support/main
- For user discussions, support, and programming examples:
  http://www.adept.com/forum/

Related Manuals

This manual covers the installation, operation, and maintenance of Adept Cobra ePLC600/800 robots. For additional manuals covering programming the system, reconfiguring installed components, and adding optional components, see the following table.

Table 1-2. Related Manuals

Manual Title	Description
Adept Robot Safety Guide	Contains safety information for Adept robots.
Adept T20 Pendant User's Guide	Describes the use of the optional Adept manual control pendant.
Adept Cobra ePLC600/800 Quick Setup Guide	Gives a condensed version of installing and setting up an Adept Cobra ePLC robot.

Adept Document Library

The Adept Document Library (ADL) contains documentation for Adept products. You can access the ADL from the Adept website. Select:

Support > Document Library

from the Adept home page. To go directly to the Adept Document Library, type the following URL into your browser:

http://www.adept.com/Main/KE/DATA/adept_search.htm

To locate information on a specific topic, use the Document Library search engine on the ADL main page. To view a list of available product documentation, use the menu links located above the search field.

Chapter 2: Robot Installation

2.1 Transport and Storage

This equipment must be shipped and stored in a temperature-controlled environment, within the range –25 C to +55 C. The recommended humidity range is 5 to 90 percent, non-condensing. It should be shipped and stored in the Adept-supplied packaging, which is designed to prevent damage from normal shock and vibration. You should protect the package from excessive shock and vibration.

Use a forklift, pallet jack, or similar device to transport the packaged equipment (see the following figure).

The robots must always be stored and shipped in an upright position in a clean, dry area that is free from condensation. Do not lay the crate on its side or any other position: this could damage the robot.

The Adept Cobra ePLC600 Robot robot weighs 41 kg (90 lb) and the Adept Cobra ePLC800 Robot weighs 43 kg (95 lb) with no options installed.

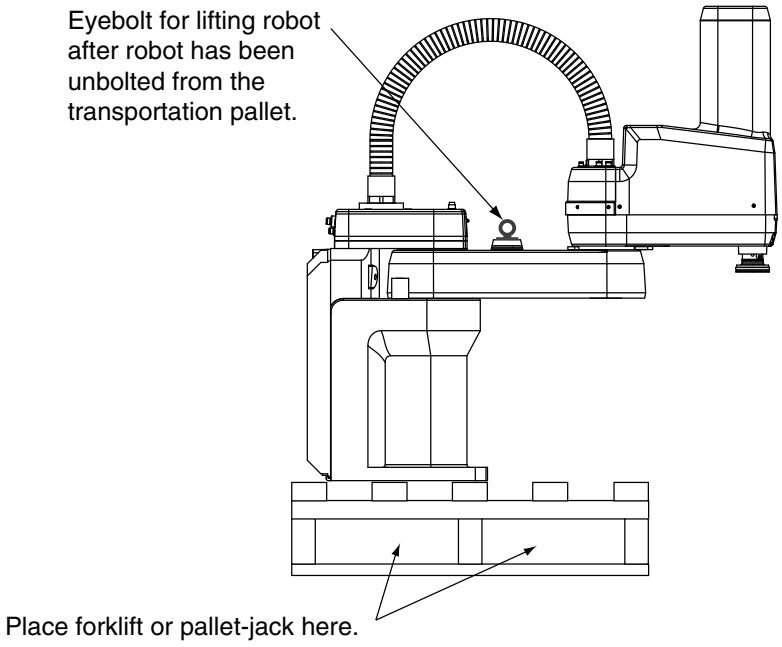

Eyebolt for lifting robot after robot has been unbolted from the transportation pallet.
Place forklift or pallet-jack here.

Figure 2-1. Adept Cobra ePLC Robot on a Transportation Pallet

2.2 Unpacking and Inspecting the Adept Equipment

Carefully inspect all shipping crates for evidence of damage during transit. Pay special attention to any tilt and shock indication labels on the exteriors of the containers. If any damage is indicated, request that the carrier's agent be present at the time the container is unpacked.

Before signing the carrier's delivery sheet, please compare the actual items received (not just the packing slip) with your equipment purchase order and verify that all items are present and that the shipment is correct and free of visible damage.

- If the items received do not match the packing slip, or are damaged, do **not** sign the receipt. Contact Adept as soon as possible.
- If the items received do not match your order, please contact Adept immediately.

Inspect each item for external damage as it is removed from its container. If any damage is evident, contact Adept. See How Can I Get Help? on page 14.

Retain all containers and packaging materials. These items may be necessary to settle claims or, at a later date, to relocate equipment.

2.3 Repacking for Relocation

If the robot or other equipment needs to be relocated, reverse the steps in the installation procedures that follow this chapter. Reuse all original packing containers and materials and follow all safety notes used for installation. Improper packaging for shipment will void your warranty. Specify this to the carrier if the robot is to be shipped.

CAUTION: Before unbolting the robot from the mounting surface, fold the outer arm against the Joint 2 hardstops to help centralize the center of gravity. The robot must always be shipped in an upright orientation.

2.4 Environmental and Facility Requirements

The Adept robot system installation must meet the operating environment requirements shown in the following table.

Table 2-1. Robot System Operating Environment Requirements

Ambient temperature	5 to 40° C (41 to 104° F)
Humidity	5 to 90%, non-condensing
Altitude	up to 2000 m (6500 ft)
Pollution degree	2
Robot protection class	IP 20 (NEMA Type 1)
NOTE: For robot dimensions, see Dimension Drawings on page 83.	

2.5 Mounting the Robot

WARNING: Only qualified service personnel may install or service the robot system.

Mounting Surface

The Adept Cobra ePLC600/800 robots are designed to be mounted on a smooth, flat, level tabletop. The mounting structure must be rigid enough to prevent vibration and flexing during robot operation. Adept recommends a 25 mm (1 in.) thick steel plate mounted to a rigid tube frame. Excessive vibration or mounting flexure will degrade robot performance. The following figure shows the mounting hole pattern for the Adept Cobra ePLC600/800 robots.

NOTE: On the under-side of the base are a hole and a slot that can be used as locating points for user-installed dowel pins in the mounting surface. See the following figure. Using locating pins can improve the ability to remove and reinstall the robot in the same position.

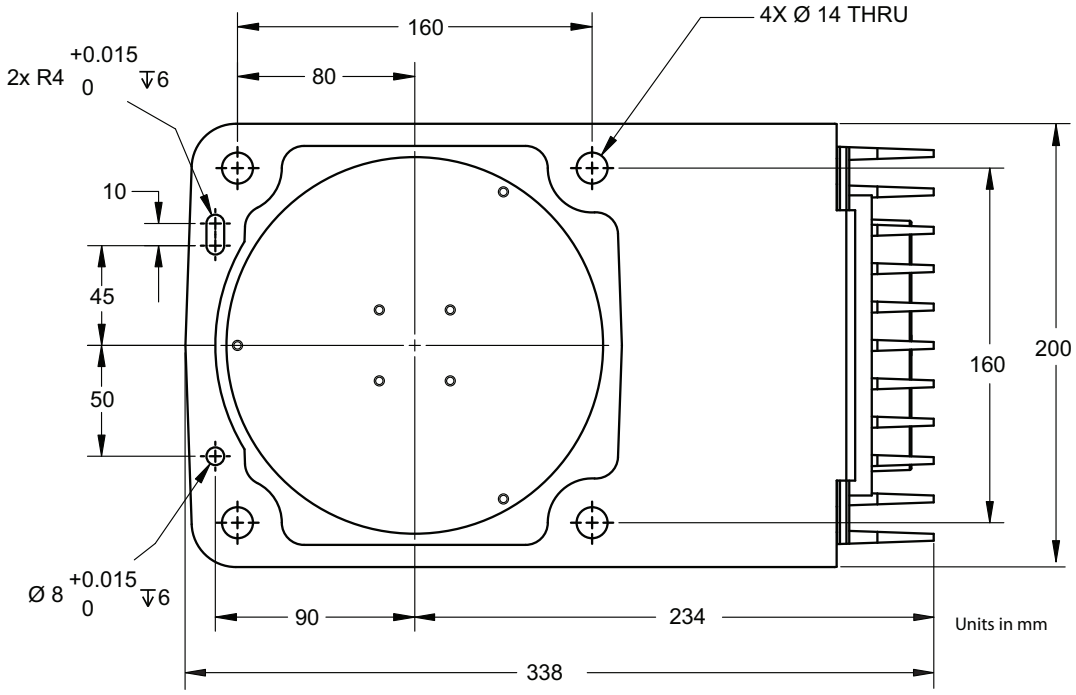


Figure 2-2. Mounting Hole Pattern for Robot

Robot Mounting Procedure

1. Using the dimensions shown in the previous figure, drill and tap the mounting surface for four M12 - 1.75 x 36 mm (or 7/16 - 14 UNC x 1.50 in.) machine bolts. Bolts are user-supplied.
2. While the robot is still bolted to the transportation pallet, connect the hydraulic lift to the eyebolt at the top of the inner link (see Chapter 2). Take up any slack, but do not lift the robot at this time.

WARNING: Do not attempt to lift the robot at any points other than the eyebolt provided. Do not extend the inner or outer links of the robot until the robot has been secured in position. Failure to comply could result in the robot falling and causing either personnel injury or equipment damage.

3. Remove the four bolts securing the robot base to the pallet.

   Retain these bolts for possible later relocation of the equipment.
4. Lift the robot and position it directly over the mounting surface.
5. Slowly lower the robot while aligning the base and the tapped mounting holes in the mounting surface.

NOTE: The base casting of the robot is aluminum and can easily be dented if bumped against a harder surface.

6. Verify that the robot is mounted squarely (can not rock back and forth) before tightening the mounting bolts.
7. Install the user-supplied mounting bolts and washers. Tighten bolts to the torque specified in the following table.

WARNING: The center of mass of the robot may cause the robot to fall over if the robot is not secured with the mounting bolts.

NOTE: Check the tightness of the mounting bolts one week after initial installation, and then recheck every 6 months. See Periodic Maintenance Schedule on page 53.

Table 2-2. Mounting Bolt Torque Specifications

Standard	Size	Specification	Torque
Metric	M12 x P1.75	ISO Property Class 8.8	85 N·m
SAE	7/16-14 UNC	SAE J429 Grade 5 or ASTM A449	65 ft-lb

2.6 Description of Connectors on Robot Interface Panel

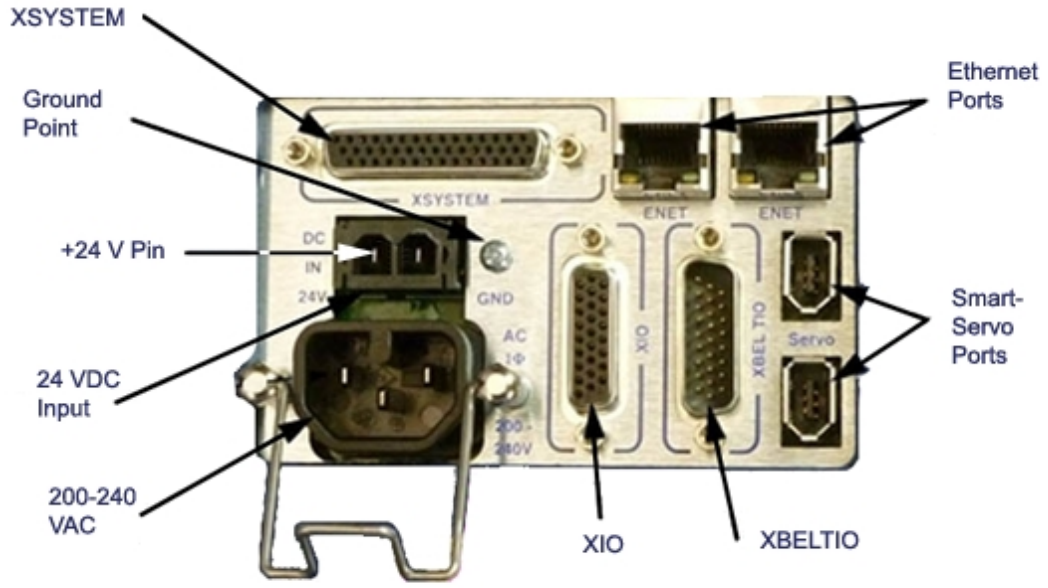


Figure 2-3. eAIB Interface Panel

24 VDC—for connecting user-supplied 24 VDC power to the robot. The mating connector is provided.

Ground Point—for connecting cable shield from user-supplied 24 VDC cable.

200/240 VAC—for connecting 200-240 VAC, single-phase, input power to the robot. The mating connector is provided.

XIO (DB26, high density, female) — for user I/O signals for peripheral devices. This connector provides 8 outputs and 12 inputs. For connector pin allocations for inputs and outputs, see Using Digital I/O on Robot XIO Connector on page 43. That section also contains signal numbers to access these I/O signals.

XSYSTEM — the XSYSTEM cable splits into the Front Panel cable, the MCP cable, for connecting to an optional T20 pendant, and an XUSR connector. See Cable and Parts List on page 23.

XBELTIO — not used for Cobra ePLC robots.

Ethernet x2 — the PLC connects to the eAIB with one of these.

Chapter 3: System Installation

3.1 System Cable Diagram

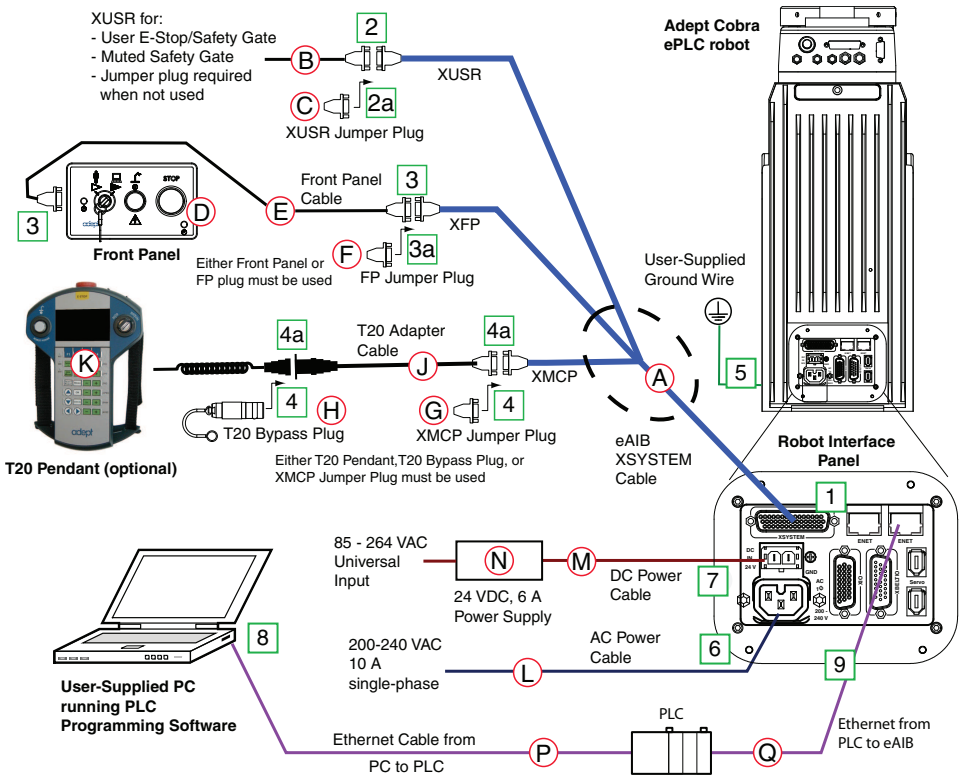


Figure 3-1. System Cable Diagram for Adept Cobra ePLC600/800 robots

NOTE: For additional system grounding information, see Installing 24 VDC Robot Cable on page 26.

3.2 Cable and Parts List

Part	Cable and Parts List	Part #	Part of:	Notes
A	eAIB XSYSTEM Cable	13323-000		standard
B	User E-Stop, Safety Gate	n/a	n/a	user-supplied
C	XUSR Jumper Plug	04736-000	13323-000	standard
D	Front Panel	90356-10358		standard

Part	Cable and Parts List	Part #	Part of:	Notes
E	Front Panel Cable	10356-10500	90356-10358	standard
F	Front Panel Jumper Plug	25165-30154	13323-000	standard
G	XMCP Bypass Jumper Plug	04737-000	13323-000	standard
H	T20 Bypass Plug	10048-000	10055-000	standard with T20
J	T20 Adapter Cable	10051-003	10055-000	standard with T20
K	T20 (optional)	10055-000		option
L	AC Power Cable (option)	04118-000	04972-000	user-supplied
M	24 VDC Power Cable (option)	04120-000	04972-000	user-supplied
N	24 VDC, 6 A Power Supply (option)	04536-000	90565-010	user-supplied
P	Ethernet Cable - PC -> PLC (Only while programming PLC)	n/a	n/a	user-supplied
Q	Ethernet Cable - PLC -> eAIB	n/a	n/a	user-supplied

Table 3-1. Cable and Parts List

3.3 Connecting 24 VDC Power to Robot

NOTE: A 24 V power supply and both VDC and VAC cables are available as options from Adept. The part numbers are listed in the preceding table.

Specifications for 24 VDC Power

Table 3-2. Specifications for 24 VDC User-Supplied Power Supply

Customer-Supplied Power Supply	24 VDC (± 10%), 150 W (6 A) (21.6 V < V_{in} < 26.4 V)
Circuit Protection[a]	Output must be less than 300 W peak or 8 Amp in-line fuse
Power Cabling	1.5 – 1.85 mm² (16-14 AWG)
Shield Termination	Braided shield connected to frame ground terminal at both ends of cable. See Figure 3-2.
[a]User-supplied 24 V power supply must incorporate overload protection to limit peak power to less than 300 W, or 8 A in-line fuse protection must be added to the 24 V power source. (In case of multiple robots on a common 24 V supply, each robot must be fused individually.)	

NOTE: Fuse information is located on the eAIB electronics.

The power requirements for the user-supplied power supply will vary depending on the configuration of the robot and connected devices. Adept recommends a 24 V, 6 A power supply to allow for startup current draw and load from connected user devices, such as solenoids and digital I/O loads. If multiple robots are sharing a 24 V power supply, increase the supply capacity by 3 A for each additional robot.

CAUTION: Make sure you select a 24 VDC power supply that meets the specifications in the previous table. Using an under-rated supply can cause system problems and prevent your equipment from operating correctly. See the following table for recommended power supplies.

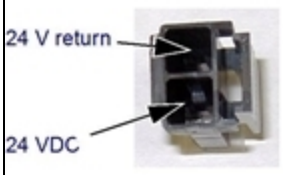
Table 3-3. Recommended 24 VDC Power Supplies

Vendor Name	Model	Ratings
XP Power	JPM160PS24	24 VDC, 6.7 A, 160 W
Astrodyne	SP-150-24	24 VDC, 6.3 A, 150 W
Mean Well	SP-150-24	24 VDC, 6.3 A, 150 W

Details for 24 VDC Mating Connector

The 24 VDC mating connector and two pins are supplied with each system. They are shipped in the cable/accessories box.

Table 3-4. 24 VDC Mating Connector Specs

Connector Details 	Connector receptacle, 2 position, type: Molex Saber, 18 A, 2-Pin Molex P/N 44441-2002 Digi-Key P/N WM18463-ND
Pin Details	Molex connector crimp terminal, female, 14-18 AWG Molex P/N 43375-0001 Digi-Key P/N WM18493-ND

Recommended crimping tool, Molex Hand Crimpers	Molex P/N 63811-0400
	Digi-Key P/N WM9907-ND

NOTE: The 24 VDC cable is not supplied with the system, but is available in the optional Power Cable kit. See Table 3-1.

Procedure for Creating 24 VDC Cable

1. Locate the connector and pins shown in Table 3-4.
2. Use 14-16 AWG wire to create the 24 VDC cable. Select the wire length to safely reach from the user-supplied 24 VDC power supply to the robot base.
3. Crimp the pins onto the wires using the crimping tool.
4. Insert the pins into the connector. Confirm that the 24 V and 24 V return wires are in the correct terminals in the plug.
5. Prepare the opposite end of the cable for connection to the user-supplied 24 VDC power supply.

Installing 24 VDC Robot Cable

1. Connect one end of the shielded 24 VDC cable to your user-supplied 24 VDC power supply. See Figure 3-2. . The cable shield should be connected to frame ground on the power supply. Do not turn on the 24 VDC power until instructed to do so in .
2. Plug the mating connector end of the 24 VDC cable into the 24 VDC connector on the interface panel on the back of the robot. The cable shield should be connected to the ground point on the interface panel.

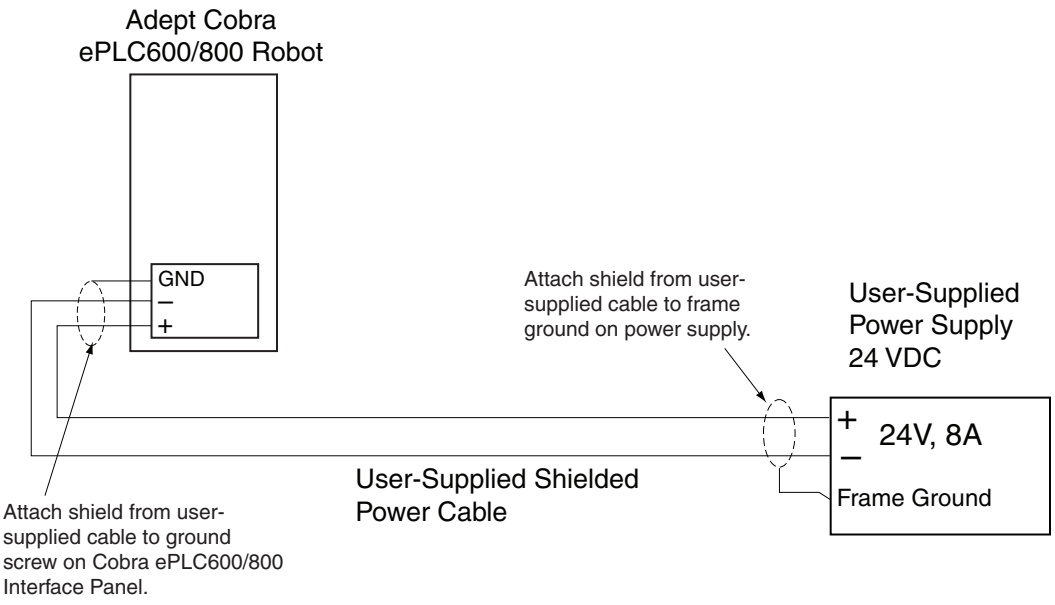


Figure 3-2. User-Supplied 24 VDC Cable

NOTE: In order to maintain compliance with standards, Adept recommends that DC power be delivered over a shielded cable, with the shield connected to frame ground at both ends of the cable.

3.4 Connecting 200-240 VAC Power to Robot

WARNING: Appropriately sized Branch Circuit Protection and Lockout / Tagout Capability must be provided in accordance with the National Electrical Code and any local codes. Ensure compliance with all local and national safety and electrical codes for the installation and operation of the robot system.

Specifications for AC Power

Table 3-5. Specifications for 200/240 VAC User-Supplied Power

Auto-Ranging Nominal Voltage Ranges	Minimum Operating Voltage[a]	Maximum Operating Voltage	Frequency/ Phasing	Recommended External Circuit Breaker, User-Supplied
200 V to 240 V	180 V	264 V	50/60 Hz 1-phase	10 Amps
[a]Specifications are established at nominal line voltage. Low line voltage can affect robot performance.				

Table 3-6. Typical Robot Power Consumption

Cobra Robot	Move	Average Power (W)	RMS Current (A)	Peak Power (W)[a]
ePLC600	No load—Adept cycle[b]	344	1.56	1559
	5.5 kg—Adept cycle[b]	494	2.25	2061
	5.5 kg—all joints move	880	4.00	2667
ePLC800	No load—Adept cycle[b]	377	1.71	1406
	5.5 kg—Adept cycle[b]	531	2.41	1955
	5.5 kg—all joints move	794	3.61	2110
[a]For short durations (100 ms). [b]For details on Adept cycle, see Robot Specifications on page 88.				

NOTE: The Adept robot system is intended to be installed as a piece of equipment in a permanently-installed system.

WARNING: Adept systems require an isolating transformer for connection to mains systems that are asymmetrical or use an isolated (impedant) neutral. Many parts of Europe use an impedant neutral.

DANGER: AC power installation must be performed by a skilled and instructed person—refer to the *Adept Robot Safety Guide*. During installation, unauthorized third parties must be prevented from turning on power through the use of fail-safe lockout measures.

Facility Overvoltages Protection

The user must protect the robot from excessive overvoltages and voltage spikes. If the country of installation requires a CE-certified installation, or compliance with IEC 1131-2, the following information may be helpful: IEC 1131-2 requires that the installation must ensure that Category II overvoltages (i.e., line spikes not directly due to lightning strikes) are not exceeded. Transient overvoltages at the point of connection to the power source shall be controlled not to exceed overvoltages Category II, i.e., not higher than the impulse voltage corresponding to the rated voltage for the basic insulation. The user-supplied equipment or transient suppressor shall be capable of absorbing the energy in the transient.

In the industrial environment, nonperiodic overvoltage peaks may appear on mains power supply lines as a result of power interruptions to high-energy equipment (such as a blown fuse on one branch in a 3-phase system). This will cause high current pulses at relatively low voltage levels. The user shall take the necessary steps to prevent damage to the robot system (such as by interposing a transformer). See IEC 1131-4 for additional information.

AC Power Diagrams

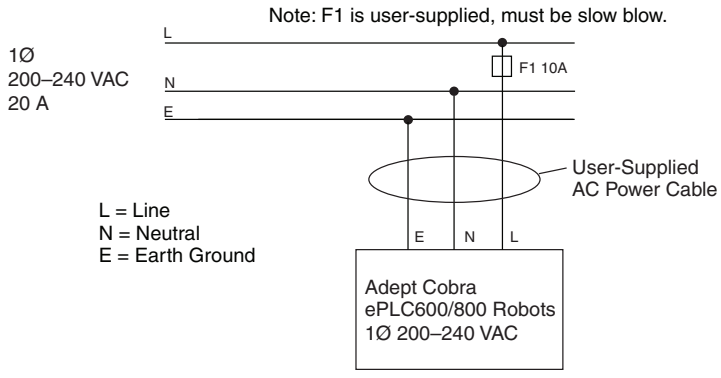


Figure 3-3. Typical AC Power Installation with Single-Phase Supply

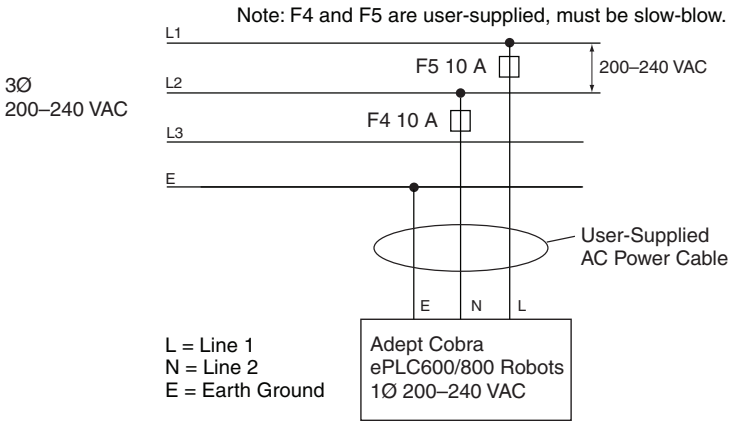


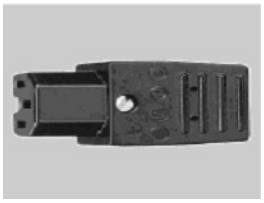
Figure 3-4. Single-Phase Load across L1 and L2 of a Three-Phase Supply

NOTE: If a three-phase power source is used, it must be symmetrically-earthed (with grounded neutral). Connections called out as single-phase can be wired Line-to-Neutral or Line-to-Line.

Details for AC Mating Connector

The AC mating connector is supplied with each system. It is shipped in the cable/accessories box. The supplied plug is internally labeled for the AC power connections (L, E, N).

Table 3-7. AC Mating Connector Details

AC Connector details 	AC in-line power plug, straight, female, screw terminal, 10 A, 250 VAC
	Qualtek P/N 709-00/00
	Digi-Key P/N Q217-ND

NOTE: The AC power cable is not supplied with the system, but is available in the optional Power Cable kit.

Creating the 200-240 VAC Cable

1. Locate the AC mating connector shown in the previous table.
2. Open the connector by unscrewing the screw on the shell and removing the cover.
3. Loosen the two screws on the cable clamp. See Figure 3-5.
4. Use 18 AWG wire to create the AC power cable. Select the wire length to safely reach from the user-supplied AC power source to the robot base.
5. Strip approximately 18 to 24 mm insulation from each of the three wires.

6. Insert the wires into the connector through the removable bushing.
7. Connect each wire to the correct terminal screw, and tighten the screw firmly.
8. Tighten the screws on the cable clamp.
9. Reinstall the cover and tighten the screw to seal the connector.
10. Prepare the opposite end of the cable for connection to the facility AC power source.

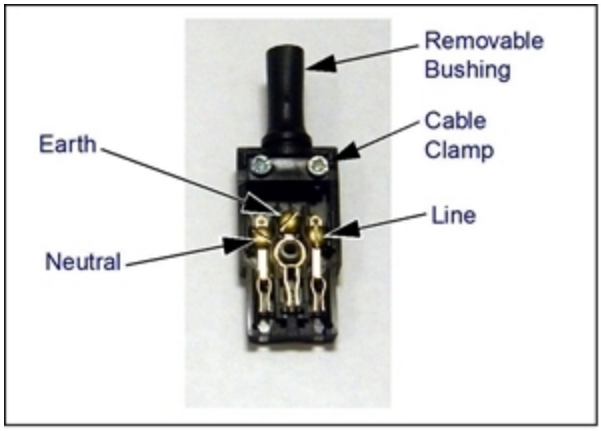


Figure 3-5. AC Power Mating Connector

Installing AC Power Cable to Robot

1. Connect the unterminated end of the AC power cable to your facility AC power source. See AC Power Diagrams on page 28. Do not turn on AC power at this time.
2. Plug the AC connector into the AC power connector on the interface panel on the robot.
3. Secure the AC connector with the locking latch.

3.5 Grounding the Adept Robot System

Proper grounding is essential for safe and reliable robot operation. Follow these recommendations to properly ground your robot system.

Grounding the Robot Base

The user can install a ground wire at the robot base to ground the robot. See Figure 3-6. The robot ships with an M8 x 12 stainless steel, hex-head screw, and M8 split and flat washers installed in the grounding hole. The user is responsible for supplying the ground wire to connect to earth ground.

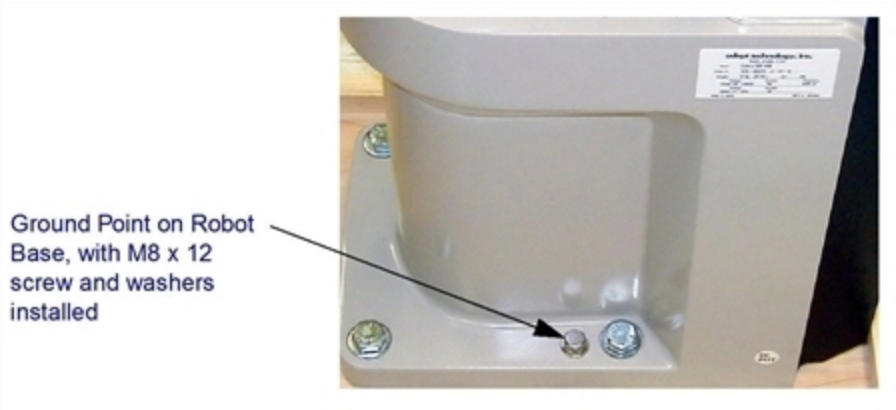


Figure 3-6. Ground Point on Robot Base

Grounding Robot-Mounted Equipment

The following parts of Adept Cobra ePLC600/800 robots are not grounded to protective earth: the Joint 3 quill and the tool flange. If hazardous voltages are present at any user-supplied robot-mounted equipment or tooling, you must install a ground connection from that equipment/tooling to the ground point on the robot base. Hazardous voltages can be considered anything in excess of 30 VAC (42.4 VAC peak) or 60 VDC.

Also, for the grounding point on the tool flange, see Tool Flange Dimensions for Both Robots on page 85.

DANGER: Failing to ground robot-mounted equipment or tooling that uses hazardous voltages could lead to injury or death of a person touching the end-effector when an electrical fault condition exists.

3.6 Connecting the PLC to the Robot

The user-supplied PLC and the ePLC Cobra need to be connected, either through a shared network, or with a direct connection using a user-supplied Ethernet cable. In the latter case, connect the cable between the PLC and either of the Ethernet connectors on the eAIB.

When the Cobra ePLC robot is powered on and waiting for a PLC connection, the robot status panel will display its IP address, two digits at a time.

The format will be:

IP xxx-xxx-xxx-xxx OK

NOTE: If you can use the default IP address, then you can skip the Adept ACE software installation completely.

Installing Adept ACE Software

You install Adept ACE software onto your PC from the Adept Software CD-ROM. Adept ACE software needs Microsoft .NET Framework. The Adept ACE Setup Wizard scans your PC for

.NET, and installs it automatically if it is not already installed. The Adept ACE software needs to be v. 3.4 or later for the connection to a PLC.

1. Insert the CD-ROM into the CD-ROM drive of your PC.

   If Autoplay is enabled, the Adept software CD-ROM menu is displayed. If Autoplay is disabled, you will need to manually start the CD-ROM.

   NOTE: The online document that describes the installation process opens in the background when you select one of the software installation steps below.

2. Especially if you are upgrading your Adept ACE software installation: from the Adept ACE software CD-ROM menu, click Read Important Information.
3. From the Adept ACE software CD-ROM menu, select:

   Install the Adept ACE Software

   The Adept ACE Setup wizard opens.
4. Follow the online instructions as you step through the installation process.
5. When the installation is complete, click Finish.
6. After closing the Adept ACE Setup wizard, click Exit on the CD-ROM menu to close the menu.

NOTE: You will have to restart the PC after installing Adept ACE software.

Setting the Robot IP Address

Set the IP address of the Cobra robot using Adept ACE software.

1. Connect the PC and the robot, either through a shared network or with an Ethernet cable between them.
2. Start the Adept ACE software.

   You will get the startup menu.
3. Click the Detect and Configure button, circled in red in the following figure.

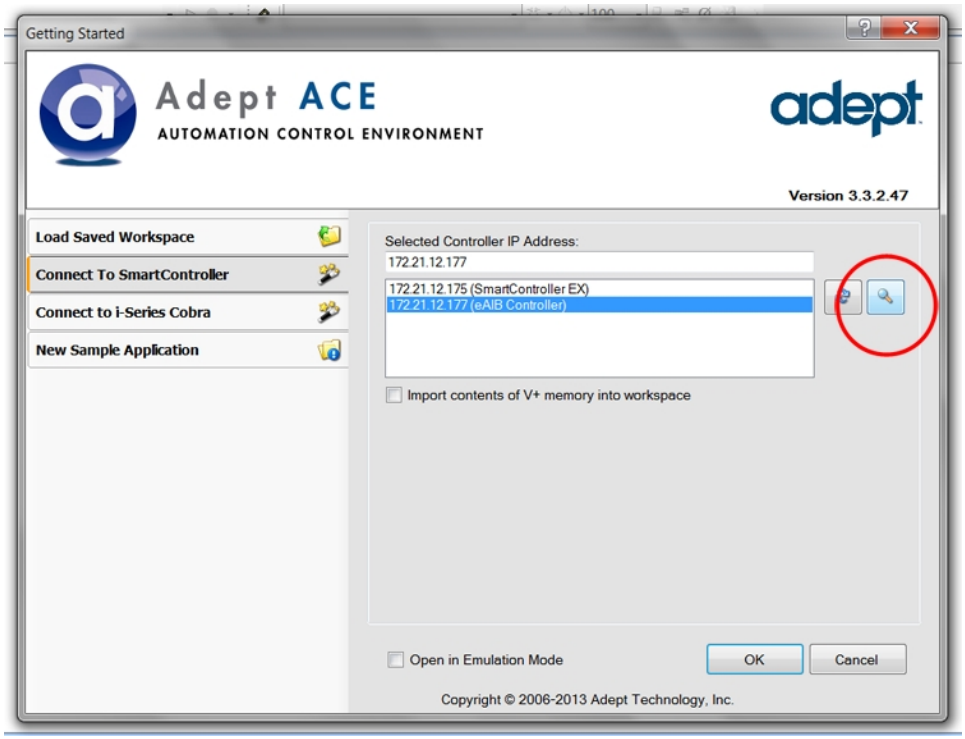


Figure 3-7. Detect and Configure Button, Circled

The IP address detection and configuration window will open. See the following figure.

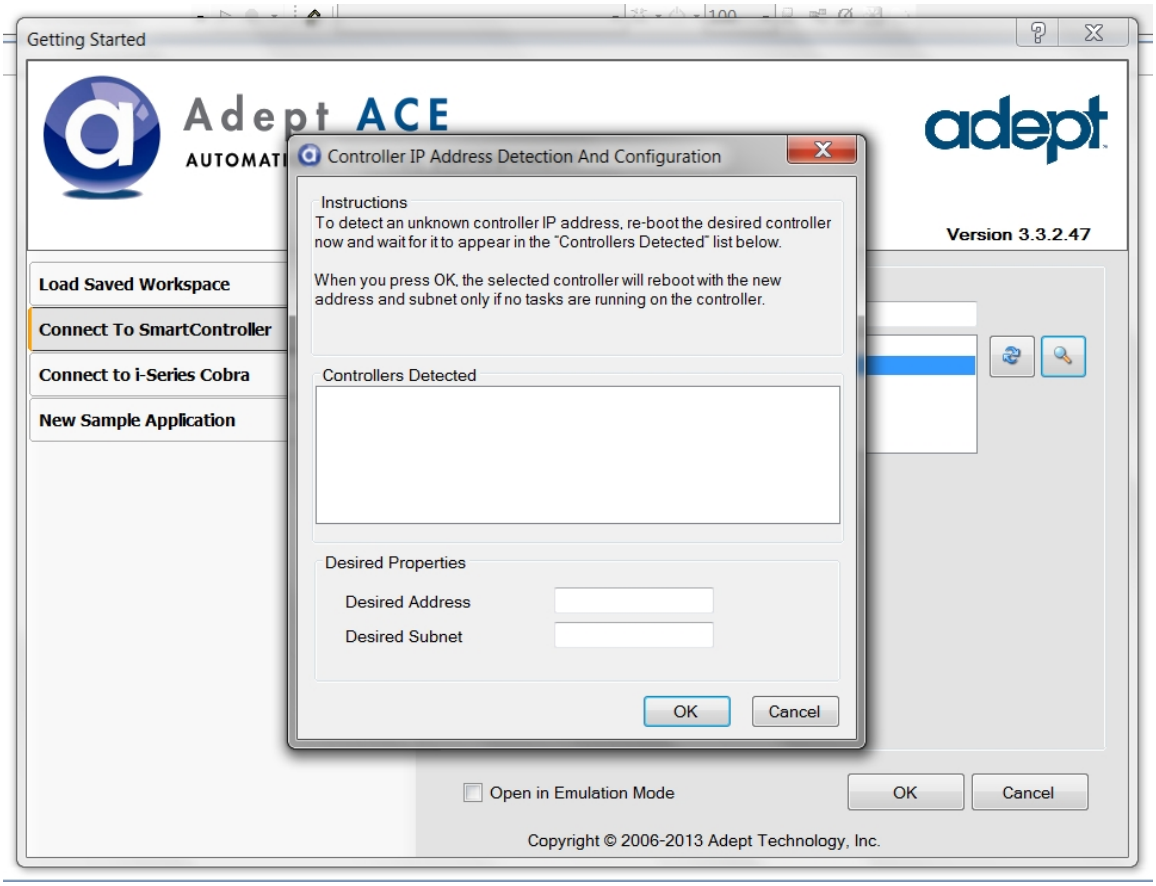

Getting Started
Adept ACE
adept
Version 3.3.2.47
Load Saved Workspace
Connect To SmartController
Connect to i-Series Cobra
New Sample Application
Controller IP Address Detection And Configuration
Instructions
To detect an unknown controller IP address, re-boot the desired controller now and wait for it to appear in the "Controllers Detected" list below.
When you press OK, the selected controller will reboot with the new address and subnet only if no tasks are running on the controller.
Controllers Detected
Desired Properties
Desired Address
Desired Subnet
OK
Cancel
Open in Emulation Mode
OK
Cancel
Copyright © 2006-2013 Adept Technology, Inc.

Figure 3-8. Detection and Configuration Window

4. Power-cycle the ePLC Cobra. Wait for it to reboot.

   The ACE software will show the IP address of any controllers it detects.

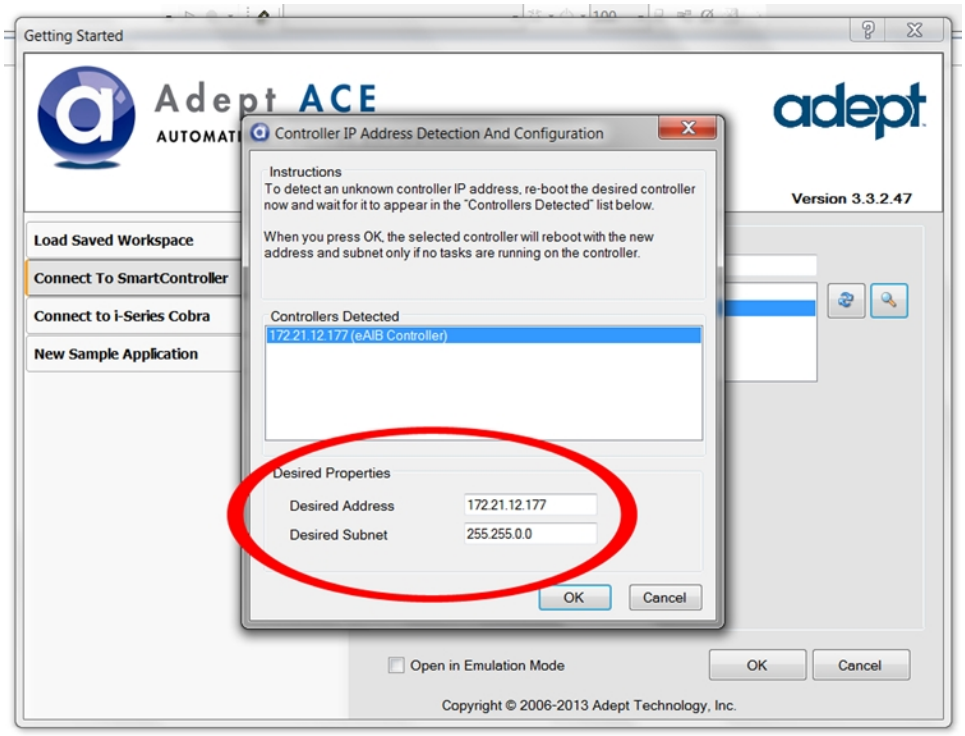

Getting Started
Adept ACE
adept
Version 3.3.2.47
Load Saved Workspace
Connect To SmartController
Connect to i-Series Cobra
New Sample Application
Controller IP Address Detection And Configuration
Instructions
To detect an unknown controller IP address, re-boot the desired controller now and wait for it to appear in the "Controllers Detected" list below.
When you press OK, the selected controller will reboot with the new address and subnet only if no tasks are running on the controller.
Controllers Detected
172.21.12.177 (eAIB Controller)
Desired Properties
Desired Address
172.21.12.177
Desired Subnet
255.255.0.0
OK
Cancel
Open in Emulation Mode
OK
Cancel
Copyright © 2006-2013 Adept Technology, Inc.

Figure 3-9. IP Addresses Detected

5. You can change the IP address and subnet mask in the Desired Address and Desired Subnet fields, if needed.
6. Click OK. The ACE software will ask you to wait for the controller to reboot.

   See the following figure.

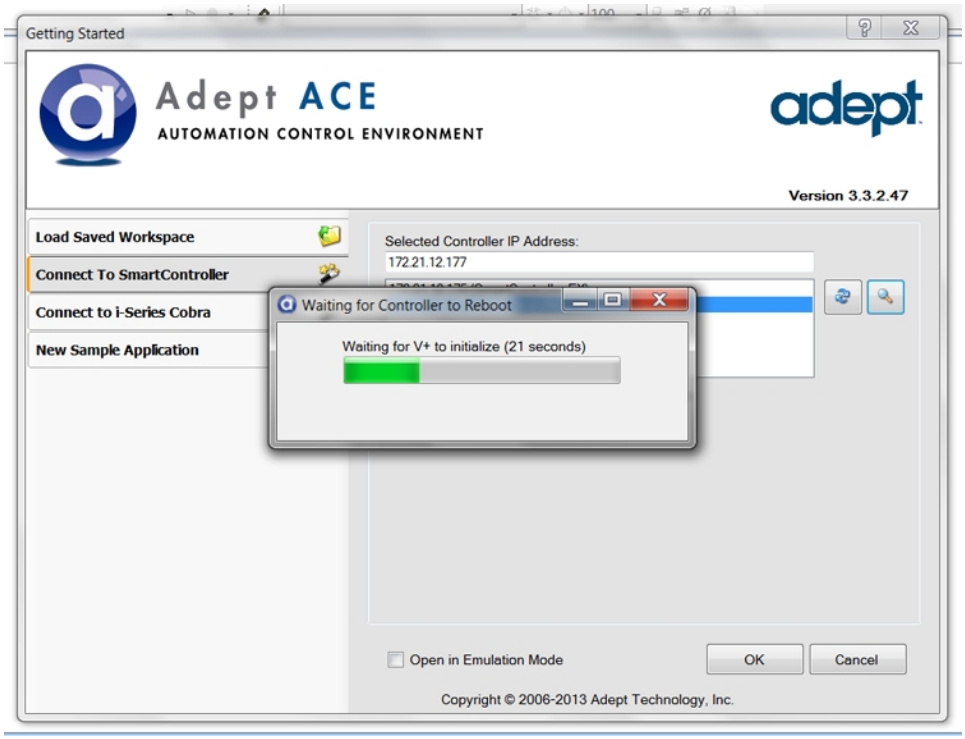


Figure 3-10. Waiting for Controller to Reboot

Setting the Robot IP Address on the PLC

Using your PLC software, set the IP address for the PLC to connect to on the robot.

The following figure is an example of an Allen Bradley PLC, with RS Logix software.

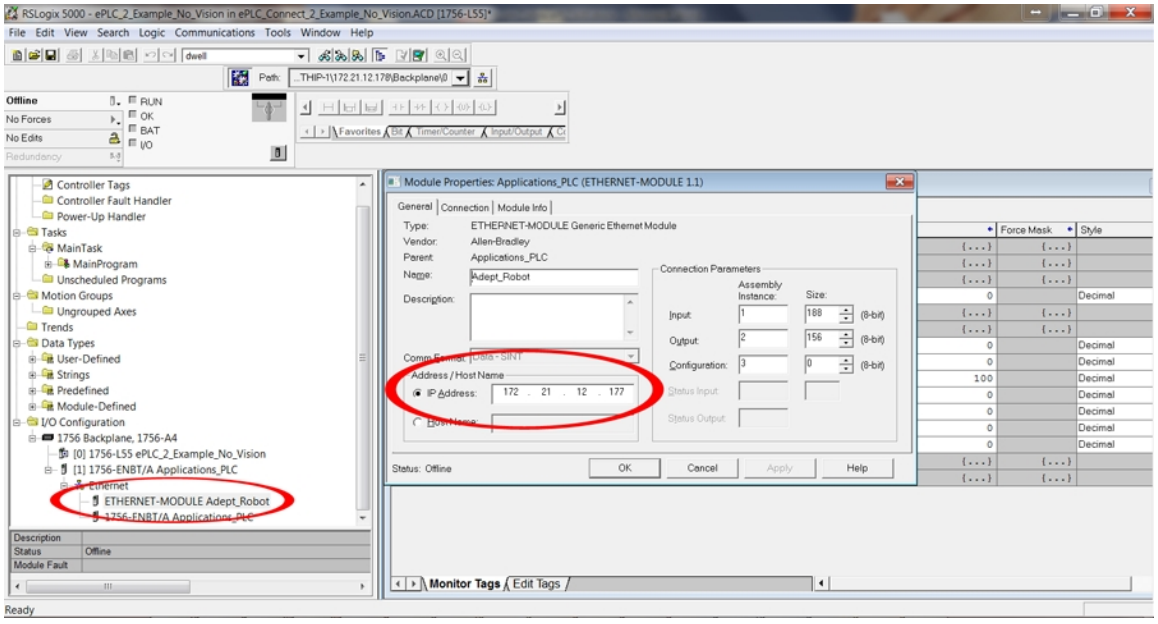


Figure 3-11. Example: Setting an IP Address with RS Logix

The PLC should now be able to communicate with the robot.

3.7 Installing User-Supplied Safety Equipment

The user is responsible for installing safety barriers to protect personnel from coming in contact with the robot unintentionally. Depending on the design of the workcell, safety gates, light curtains, and emergency stop devices can be used to create a safe environment. Read the *Adept Robot Safety Guide* for a discussion of safety issues.

Chapter 4: System Operation

4.1 Robot Status LED Description

The robot Status LED indicator is located on the top of the robot. The blinking pattern indicates the status of the robot.

The Adept Cobra ePLC robots support the UL standard. The LED on these robots is amber. See the following figure and table.

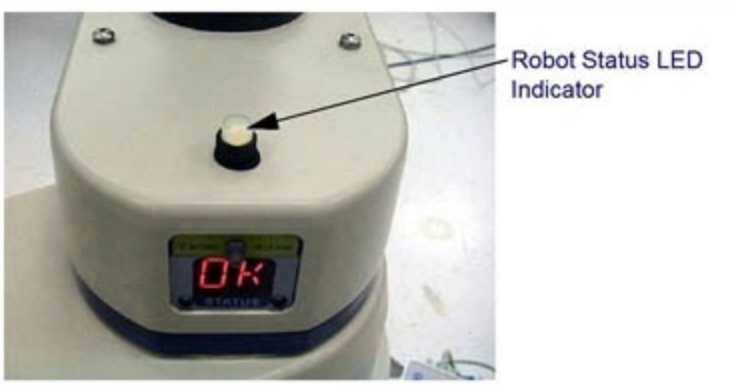


Figure 4-1. Robot Status LED Indicator Location

Table 4-1. Status LED Definitions on UL-Certified Robots

LED Status	2-Digit Status Panel Display	Description
Off	Off	24 VDC not present
Off	OK	High Power Disabled
Amber, Solid	ON	High Power Enabled
Amber, Slow Blink	N/A	Selected Configuration Node
Amber, Fast Blink	Fault Code(s)	Fault, see the next section
Amber, Solid	Fault Code(s)	Fault, see the next section

4.2 Status Panel Fault Codes

The status panel, shown in the following figure, displays alpha-numeric codes that indicate the operating status of the robot, including detailed fault codes. The following table gives meanings of the fault codes. These codes provide information for quickly isolating problems during troubleshooting.

The displayed fault code will continue to be displayed even after the fault is corrected or additional faults are recorded. All displayed faults will be cleared from the display, and reset to a no-fault condition, upon successfully enabling high power to the robot, or power cycling the 24 V supply to the robot.

Figure 4-2. Status Panel

Table 4-2. Status Panel Codes

LED	Status Code	LED	Status Code
OK	No Fault	H#	High Temp Encoder (Joint #)
ON	High Power ON Status	hV	High Voltage Bus Fault
MA	Manual Mode	I#	Initialization Stage (Step #)
24	24 V Supply Fault	M#	Motor Stalled (Joint #)
A#	Amp Fault (Joint #)	NC	PLC/Cobra ePLC not connected
B#	IO Blox Fault (Address #)	NV	Non-Volatile Memory
AC	AC Power Fault	P#	Power System Fault (Code #)
D#	Duty Cycle Exceeded (Joint #)	PR	Processor Overloaded
E#	Encoder Fault (Joint #)	RC	RSC Fault
Er	Application Error, which needs an acknowledgment from PLC	S#	Safety System Fault (Code #)
ES	E-Stop	SE	E-Stop Delay Fault
F#	External Sensor Stop	SW	Watchdog Timeout
FM	Firmware Mismatch	T#	Safety System Fault (Code 10 + #)
FW	IEEE 1394 Fault	TR	Teach Restrict Fault
h#	h# High Temp Amp (Joint #)	V#	Hard Envelope Error (Joint #)

For more information on status codes, go to the Adept Document Library on the Adept website, and in the Procedures, FAQs, and Troubleshooting section, look for the *Adept Status Code Summary* document.

4.3 Brakes

The robot has a braking system that decelerates the robot in an emergency condition, such as when the emergency stop circuit is open or a robot joint passes its softstop.

The braking system will not prevent you from moving the robot manually once the robot has stopped (and high power has been removed).

In addition, Joint 3 has an electromechanical brake. The brake is released when high power is enabled. When high power is turned off, the brake engages and holds the position of Joint 3.

Brake Release Button

Under some circumstances you may want to manually position Joint 3 on the Z-Axis without turning on high power. For such instances, a 'Z' Brake Release button is located above the robot status panel, as shown in Figure 4-2. When 24 V system power is on, pressing this button releases the brake, which allows movement of Joint 3.

NOTE: 24 Volt robot power must be ON to release the brake.

If this button is pressed while high power is on, high power will automatically shut down.

WARNING: When the Brake Release button is pressed, Joint 3 may drop to the bottom of its travel. To prevent possible damage to the equipment, make sure that Joint 3 is supported while releasing the brake and verify that the end-effector or other installed tooling is clear of all obstructions.

4.4 Front Panel

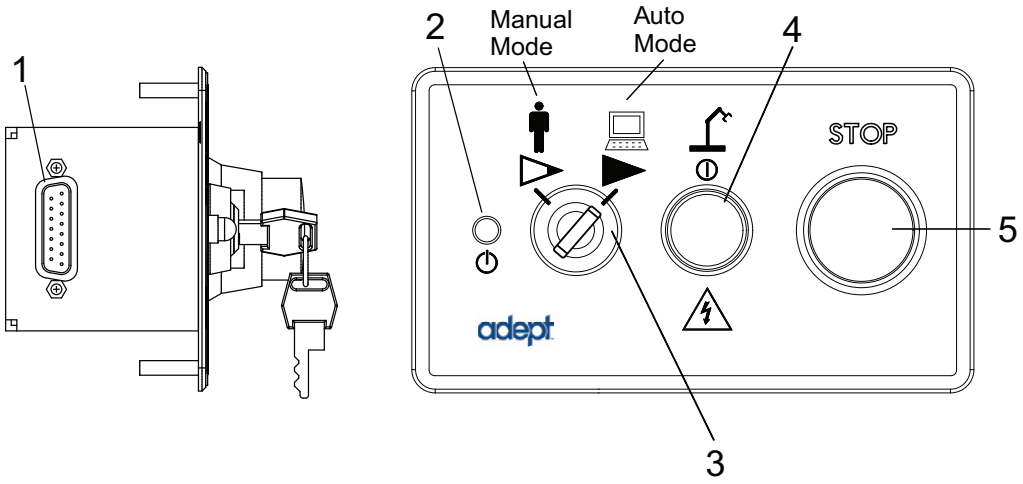


Figure 4-3. Front Panel

1. **XFP connector**
   Connects to the XFP connector on the XSYSTEM cable.
2. **System 5 V Power-On LED**
   Indicates whether or not power is connected to the robot.
3. **Manual/Automatic Mode Switch**
   Switches between Manual and Automatic mode. In Automatic mode, executing programs control the robot, and the robot can run at full speed. In Manual mode, the system limits robot speed and torque so that an operator can safely work in the cell. Manual mode initiates software restrictions on robot speed, commanding no more than 250 mm/sec.
4. **High Power On/Off Switch and Lamp**
   Controls high power, which is the flow of current to the robot motors. Enabling high power is a two-step process. An "Enable Power" request must be sent from the user-supplied PC, an executing program, or the Adept pendant. Once this request has been made and the High Power On/Off lamp/button is blinking, the operator must press and release this button, and high power will be enabled.

   NOTE: The use of the blinking High Power button can be configured (or eliminated) in software. Your system may not require this step.

   NOTE: If enabled, the Front Panel button must be pressed while blinking (default time-out is 10 seconds). If the button stops blinking, you must enable power again.
5. **Emergency Stop Switch**
   The E-Stop is a dual-channel, passive E-Stop that supports Category 3 CE safety requirements. Pressing this button turns off high power to the robot motors.

NOTE: The Front Panel or its jumper plug must be installed before you can Enable Power to the robot. To operate without a Front Panel, the user must supply equivalent circuits.

4.5 Connecting Digital I/O to the System

You can connect digital I/O to the system from the eAIB or from your PLC. The following section addresses the eAIB I/O only, as different PLCs may use different I/O setups.

Table 4-3. Digital I/O Connection Options

Product	I/O Capacity	For more details
XIO Connector on Robot	12 inputs 8 outputs	see Using Digital I/O on Robot XIO Connector on page 43

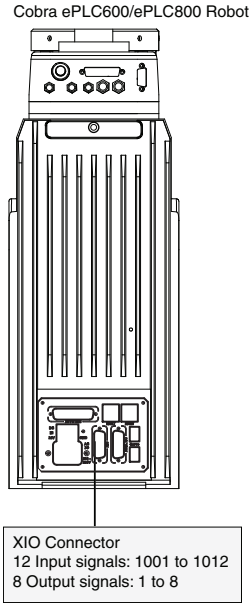


Figure 4-4. Connecting Digital I/O to the System

Table 4-4. Default Digital I/O Signal Configuration, Single Robot System

Location	Type	Signal Range
Robot 1 XIO connector	Inputs	1001–1012
	Outputs	0001–0008

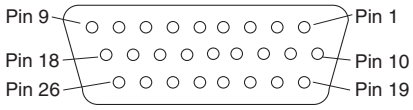
Using Digital I/O on Robot XIO Connector

The XIO connector on the robot interface panel offers access to digital I/O, 12 inputs and 8 outputs. These signals can be used to perform various functions in the workcell. See the following table for the XIO signal designations.

Table 4-5. XIO Signal Designations

Pin No.	Designation	Signal Bank	Signal Number
1	GND		
2	24 VDC		
3	Common 1	1	
4	Input 1.1	1	1001
5	Input 2.1	1	1002
6	Input 3.1	1	1003

Pin No.	Designation	Signal Bank	Signal Number
7	Input 4.1	1	1004
8	Input 5.1	1	1005
9	Input 6.1	1	1006
10	GND		
11	24 VDC		
12	Common 2	2	
13	Input 1.2	2	1007
14	Input 2.2	2	1008
15	Input 3.2	2	1009
16	Input 4.2	2	1010
17	Input 5.2	2	1011
18	Input 6.2	2	1012
19	Output 1		0001
20	Output 2		0002
21	Output 3		0003
22	Output 4		0004
23	Output 5		0005
24	Output 6		0006
25	Output 7		0007
26	Output 8		0008



Optional I/O Products

These optional products are also available for use with digital I/O:

- **XIO Breakout Cable** For information, see XIO Breakout Cable on page 48. This cable is not compatible with the XIO Termination Block.
- **XIO Termination Block**, with terminals for user wiring, plus input and output status LEDs. Connects to the XIO connector with 6 foot cable. See the *Adept XIO Termination Block Installation Guide* for details.

XIO Input Signals

The 12 input channels are arranged in two banks of six. Each bank is electrically isolated from the other bank and is optically isolated from the robot's ground. The six inputs within each bank share a common source/sink line.

The inputs are accessed through direct connection to the XIO connector (see the previous table), or through the optional XIO Termination Block. See the documentation supplied with the termination block for details.

The XIO inputs cannot be used for REACTI programming, high-speed interrupts, or vision triggers.

XIO Input Specifications

Table 4-6. XIO Input Specifications

Operational voltage range	0 to 30 VDC
OFF state voltage range	0 to 3 VDC
ON state voltage range	10 to 30 VDC
Typical threshold voltage	V_{in} = 8 VDC
Operational current range	0 to 7.5 mA
OFF state current range	0 to 0.5 mA
ON state current range	2.5 to 7.5 mA
Typical threshold current	2.0 mA
Impedance (V_{in}/I_{in})	3.9 kΩ minimum
Current at V_{in} = +24 VDC	$I_{in} \leq$ 6 mA
Turn on response time (hardware) Software scan rate/response time	5 µsec maximum 16 ms scan cycle/ 32 ms max response time
Turn off response time (hardware) Software scan rate/response time	5 µsec maximum 16 ms scan cycle/ 32 ms max response time

NOTE: The input current specifications are provided for reference. Voltage sources are typically used to drive the inputs.

Typical Input Wiring Example

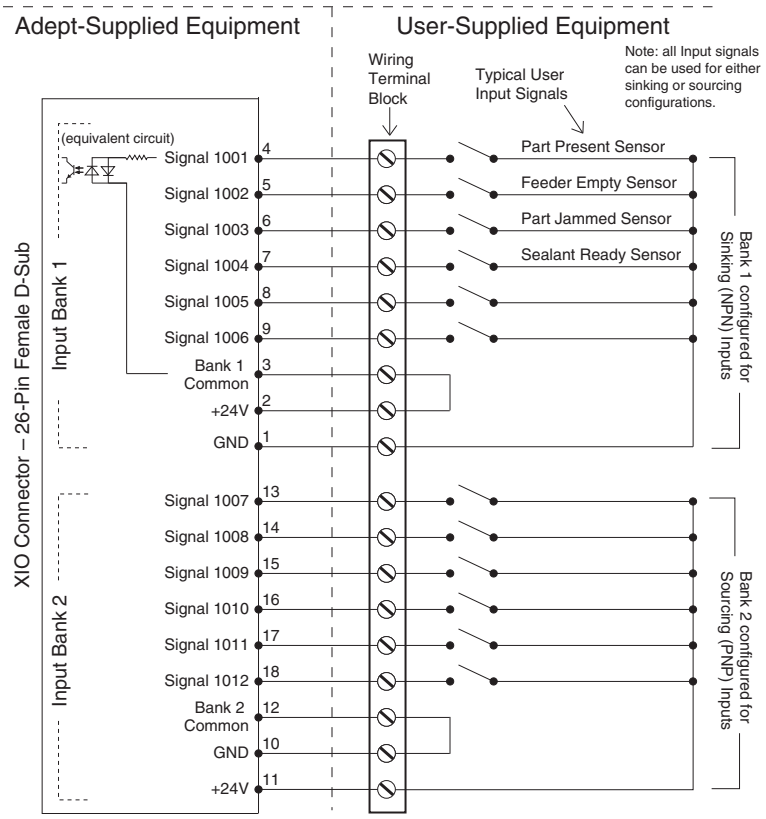


Figure 4-5. Typical User Wiring for XIO Input Signals

NOTE: The OFF state current range exceeds the leakage current of XIO outputs. This guarantees that the inputs will not be turned on by the leakage current from the outputs. This is useful in situations where the outputs are looped-back to the inputs for monitoring purposes.

XIO Output Signals

The eight digital outputs share a common, high side (sourcing) driver IC. The driver is designed to supply any kind of load with one side connected to ground. It is designed for a range of user-provided voltages from 10 to 24 VDC and each channel is capable of up to 0.7 A of current. This driver has overtemperature protection, shorted load protection, and is current limiting. In the event of an output short or other overcurrent situation, the affected output of the driver IC turns off and back on automatically to reduce the temperature of the IC. The driver draws power from the primary 24 VDC input to the robot through a self-resetting polyfuse.

The outputs are accessed through direct connection to the XIO connector (see Table 4-5). Optionally, use the XIO Termination Block. See the documentation supplied with the termination block for details.

XIO Output Specifications

Table 4-7. XIO Output Circuit Specifications

Parameter	Value
Power supply voltage range	See Specifications for 24 VDC Power on page 24.
Operational current range, per channel	$I_{out} \leq 700$ mA
Total Current Limitation, all channels on.	$I_{total} \leq 1.0$ A @ 50° C ambient $I_{total} \leq 1.5$ A @ 25° C ambient
ON state resistance (I_{out} = 0.5 A)	$R_{on} \leq 0.32\ \Omega$ @ 85° C
Output leakage current	$I_{out} \leq 25\ \mu A$
Turn on response time	125 µsec max., 80 µsec typical (hardware only)
Turn off response time	60 µsec. max., 28 µsec typical (hardware only)
Output voltage at inductive load turnoff (I_{out} = 0.5A, Load = 1 mH)	$(+V - 65) \leq V_{demag} \leq (+V - 45)$
DC short circuit current limit	$0.7A \leq I_{LIM} \leq 2.5$ A
Peak short circuit current	$I_{ovpk} \leq 4$ A

Typical Output Wiring Example

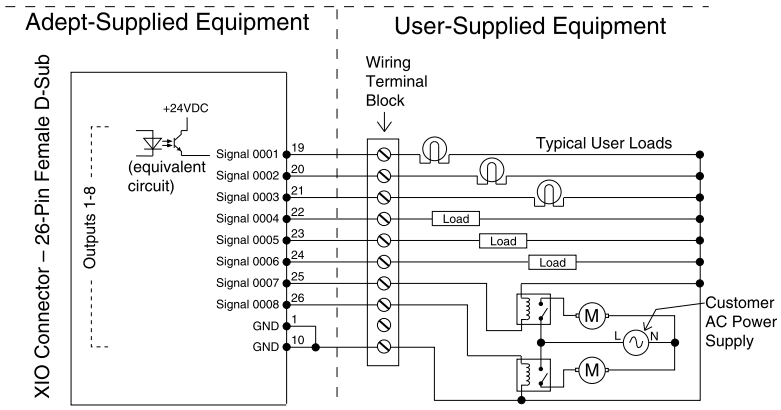


Figure 4-6. Typical User Wiring for XIO Output Signals

XIO Breakout Cable

The XIO Breakout cable is available as an option—see the following figure. This cable connects to the XIO connector on the eAIB, and provides flying leads on the user's end, for connecting input and output signals in the workcell. The cable length is 5 M (16.4 ft).

For the wire chart on the cable, see the following table.

NOTE: This cable is not compatible with the XIO Termination Block.

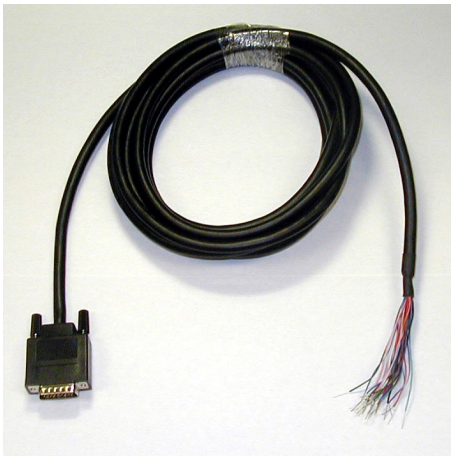
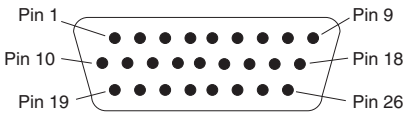


Figure 4-7. Optional XIO Breakout Cable

Table 4-8. XIO Breakout Cable Wire Chart

Pin No.	Signal Designation	Wire Color
1	GND	White
2	24 VDC	White/Black
3	Common 1	Red
4	Input 1.1	Red/Black
5	Input 2.1	Yellow
6	Input 3.1	Yellow/Black
7	Input 4.1	Green
8	Input 5.1	Green/Black
9	Input 6.1	Blue
10	GND	Blue/White
11	24 VDC	Brown
12	Common 2	Brown/White
13	Input 1.2	Orange
14	Input 2.2	Orange/Black
15	Input 3.2	Gray
16	Input 4.2	Gray/Black
17	Input 5.2	Violet
18	Input 6.2	Violet/White
19	Output 1	Pink
20	Output 2	Pink/Black
21	Output 3	Light Blue
22	Output 4	Light Blue/Black
23	Output 5	Light Green
24	Output 6	Light Green/Black
25	Output 7	White/Red
26	Output 8	White/Blue
Shell		Shield



4.6 Starting the System for the First Time

Follow the steps in this section to safely bring up your robot system. The steps include:

- Verifying installation, to confirm that all tasks have been performed correctly
- Starting up the system by turning on power for the first time
- Verifying all E-Stops in the system function correctly
- Move each axis of the robot to confirm it moves in the proper directions

Verifying Installation

Verifying that the system is correctly installed and that all safety equipment is working correctly is an important process. Before using the robot, make the following checks to ensure that the robot has been properly installed.

DANGER: After installing the robot, you must test it before you use it for the first time. Failure to do this could cause death, or serious injury or equipment damage.

Mechanical Checks

Verify that:

- The robot is mounted level and that all fasteners are properly installed and tightened.
- Any end-of-arm tooling is properly installed.
- All other peripheral equipment is properly installed and in a state such that it is safe to turn on power to the robot system.

System Cable Checks

Verify the following connections:

- User-supplied 24 VDC power to the robot 24 VDC connector.
- User-supplied 200/240 VAC power to the robot 200/240 VAC connector.

User-Supplied Safety Equipment Checks

Verify that all user-supplied safety equipment and E-Stop circuits are installed correctly.

Start-up Procedure

After the system installation has been verified, you are ready to turn on power to the system.

1. Manually move the robot joints away from the folded shipping position. See Mounting the Robot on page 19.
2. Turn on the 200/240 VAC power.

3. Turn on the 24 VDC power to the robot.
    - The Status Panel displays OK.
    - The Robot Status LED will be off.
4. Verify the Auto/Manual switch on the Front Panel is set to Auto Mode.
5. Switch on the PLC.

The Adept web site has some examples for the Allen Bradley PLC using RS Logix:

http://www.adept.com/index.php?option=com_content&view=article&id=367&Itemid=484&dir=JSROOT%2FDownload-Library/ePLC-Examples

This gives some examples to start with.

Using the PLC to Enable High Power

The details of enabling high power to the robot will vary, depending on the software running on your PLC. The following screen shot shows RS Logix 5000 being used to enable high power.

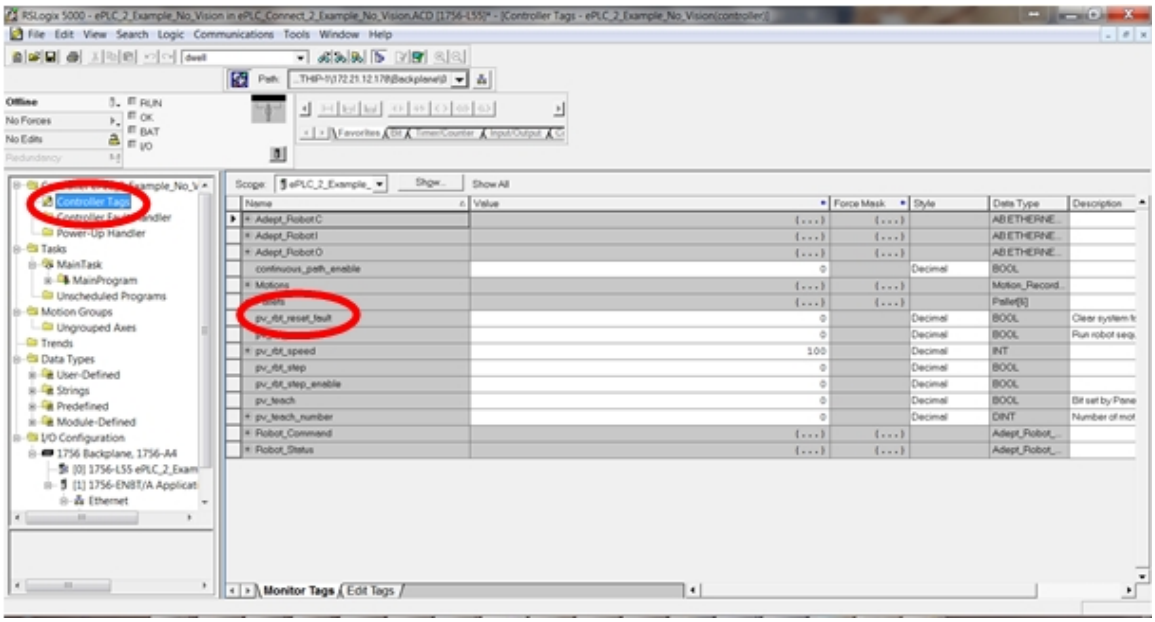


Figure 4-8. Example: Enabling High Power with RS Logix

In this example, double-clicking Controller Tags, and then setting the value of pv_rbt_reset_fault to 1 will enable high power on the robot.

NOTE: pv_rbt_reset_fault is the name for a register which is fixed when downloading the PLC code example from the Adept Web site.

NOTE: The use of the blinking High Power button can be configured (or eliminated) in software. Your system may not require this step.

Once high power is enabled, the Robot Status Panel displays ON, and the Robot Status LED will be lit.

Verifying E-Stop Functions

Verify that all E-Stop devices are functional (pendant, Front Panel, and user-supplied). Test each mushroom button, safety gate, light curtain, etc., by enabling high power and then opening the safety device. The High Power push button/light on the Front Panel should go out for each.

Verify Robot Motions

Use the pendant (if purchased) to verify that the robot moves correctly. Refer to your Adept pendant user's guide for complete instructions on using the pendant.

Chapter 5: Maintenance

5.1 Field-replaceable Parts

WARNING: Only qualified service personnel may install or service the robot system.

The following parts are the only field-replaceable parts:

Table 5-1. Field-replaceable Parts

Part	Adept Part Number
Encoder battery	09977-000 (3.6 V, 6.8 Ah) (This has replaced part number 02704-000)
eAIB (Amp-In-Base)	11472-000

These parts must only be replaced with the Adept part numbers in the preceding table.

5.2 Periodic Maintenance Schedule

The following table gives a summary of the preventive maintenance procedures and guidelines on frequency.

Also, for cleanroom robots, see Cleanroom Robots on page 103; for IP-65 robots, see IP-65 Option on page 91

Table 5-2. Inspection and Maintenance

Item	Period	Reference
Check E-Stop, enable and key switches, and barrier interlocks	6 months	See Checking Safety Systems on page 54
Check robot mounting bolts	6 months	See Checking Robot Mounting Bolts on page 54
Check for signs of oil around of harmonic drive area.	3 months	See Checking Robot for Oil around Harmonic Drive on page 55.
Lubricate Joint 3 (Z-axis) ball screw	3 months	See Lubricating Joint 3 on page 55
Replace encoder battery	5 to 10 years	See Replacing the Encoder Battery Pack on page 66

NOTE: The frequency of these procedures will depend on the particular system, its operating environment, and amount of usage. Use the times in this table as guidelines and modify the schedule as needed.

WARNING: Lockout and tagout power before servicing.

WARNING: The procedures and replacement of parts mentioned in this section should be performed only by skilled or instructed persons, as defined in the *Adept Robot Safety Guide*. The access covers on the robot are not interlocked – turn off and disconnect power if covers or the eAIB will be removed.

5.3 Checking Safety Systems

These tests should be done every six months.

1. Test operation of:
   - E-Stop button on Front Panel
   - E-Stop button on pendant
   - Enabling switch on pendant
   - Auto/Manual switch on Front Panel

   NOTE: Operating **any** of the above switches should disable high power.

2. Test operation of any external (user-supplied) E-Stop buttons.
3. Test operation of barrier interlocks, etc.

5.4 Checking Robot Mounting Bolts

Check the tightness of the base mounting bolts after one week, and then every 6 months. Tighten to 85 N·m (63 ft-lb). Also check the tightness of all cover plate screws.

5.5 Checking Robot for Oil around Harmonic Drive

The Adept Cobra ePLC600 and ePLC800 robots use oil in the harmonic drive components for lubrication. Periodically inspect the robot for any signs of oil in areas immediately outside of the harmonic drive. Check these locations:

- the area around Joint 1
- the area around Joint 2
- inside the base of the robot, by opening the eAIB chassis and inspecting internally.

WARNING: Remove all power to the robot before opening the eAIB chassis.

Contact Adept if you find any signs of oil in these areas.

5.6 Lubricating Joint 3

Use LG-2 Grease
(Lithium Soap/Synthetic Hydrocarbon),
Adept part number: 90401-04029.

CAUTION: Using improper lubrication products on the Adept Cobra ePLC600/800 robots may cause damage to the robot.

Lubrication Procedure

1. Turn off main power to the robot.

   Lock out and tag out power.

2. Remove the outer link cover by removing screws located on the sides and top of the cover. Carefully remove the cover.

WARNING: When the outer link cover is removed, you see the label shown in Figure 6-4. Do not remove the J3-ENC or J4-ENC encoder cable connectors from their sockets. If they are removed, the calibration data will be lost and the robot must be run through a factory recalibration process, which requires special software and tools.

For the IP-65 version, refer to for instructions on removing the link cover, and for instructions on removing the bellows.

For the Cleanroom version, refer to for instructions on removing the bellows. The outer link cover is standard.

3. Switch on 24 VDC power to the robot.
4. Press the brake button and move Joint 3 to the top of its travel.

   Remove any existing grease with a clean, lint-free, soft cloth.
5. Using a syringe, apply a small bead of grease to the Joint 3 ball screw grooves, see Figure 5-1.

   Apply grease to the three vertical grooves and the spiral groove.
6. Press the brake button and move Joint 3 to the bottom of its travel.

   Remove any existing grease with a clean, lint-free, soft cloth.
7. Apply a small bead of grease to any grooves of the ball screw that are now exposed.
8. Move Joint 3 up and down several times to spread the grease evenly.
9. Remove 24 VDC power from the robot.
10. Reinstall the outer link cover.

    For the Cleanroom version, replace the bellows.

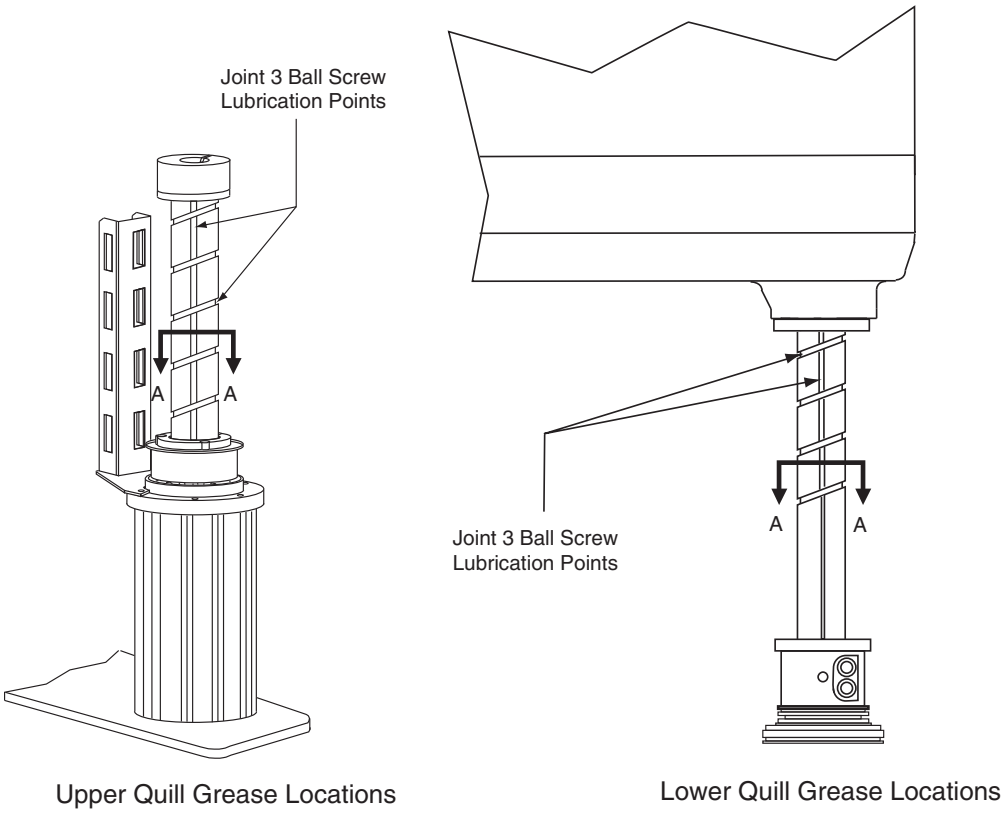


Figure 5-1. Lubrication of Joint 3 Quill

5.7 Replacing the eAIB Chassis

CAUTION: Follow appropriate ESD procedures during the removal/replacement phases.

Removing the eAIB Chassis

1. Switch off the 24 VDC input supply to the chassis.
2. Switch off the 200/240 VAC input supply to the chassis.

   Lock out and tag out power.
3. Disconnect the 24 VDC supply cable from the chassis +24 VDC input connector.
4. Disconnect the 200/240 VAC supply cable from the chassis AC Input connector.
5. Disconnect the eAIB XSYSTEM cable from the chassis XSYSTEM connector.
6. Disconnect any other cables, which may be connected to the chassis, such as Ethernet, or any others.
7. Using a 5 mm hex wrench, carefully unscrew the chassis securing screw, which is shown in the following figure. Note that the screw does not need to be completely removed in order to remove the chassis, as this screw is captured on the chassis heat sink.

Figure 5-2. Securing Screw on eAIB Chassis

8. While holding the chassis heat sink, carefully and slowly lower the chassis down (see the following figure), so that enough access is available to remove the internal cables. The chassis can be laid flat or placed to the right side of the robot for better access.

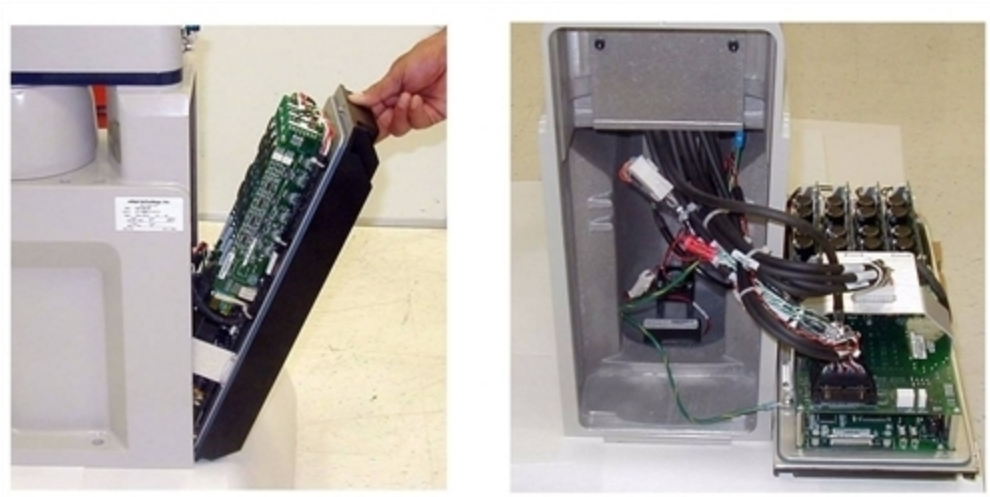


Figure 5-3. Opening and Removing Chassis

9. Disconnect the "white" amplifier cable from the amplifier connector located on the chassis bracket. See the following figure.

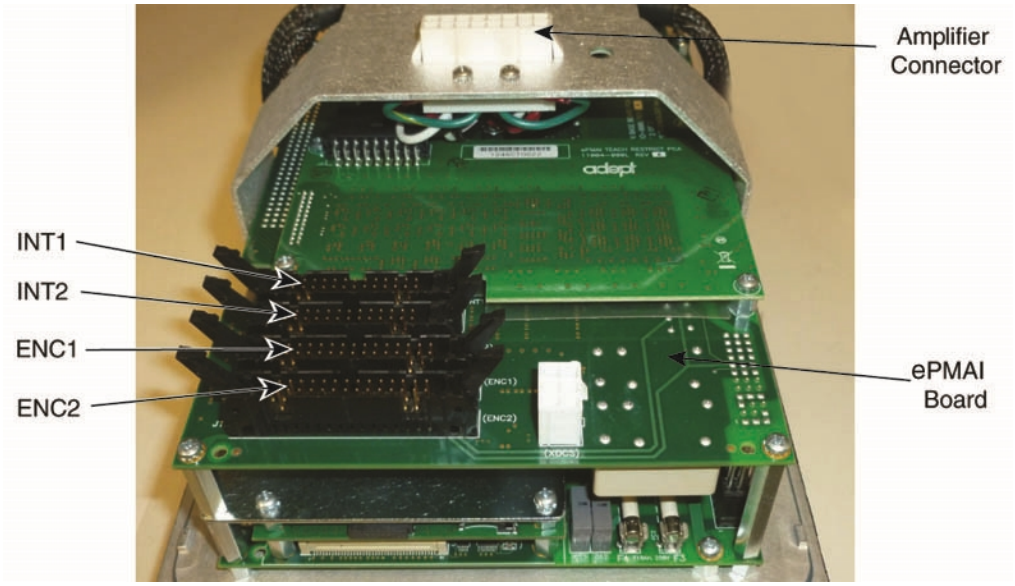


Figure 5-4. Connectors on Chassis and ePMAI Board

10. Carefully disconnect the INT1, INT2, ENC1, and ENC2 cables from their connectors on the ePMAI board, by disengaging the securing latches:
11. Using a 5 mm hex wrench, disconnect and remove the ground wire from the chassis. Keep the screw for reassembly later. See the following figure.

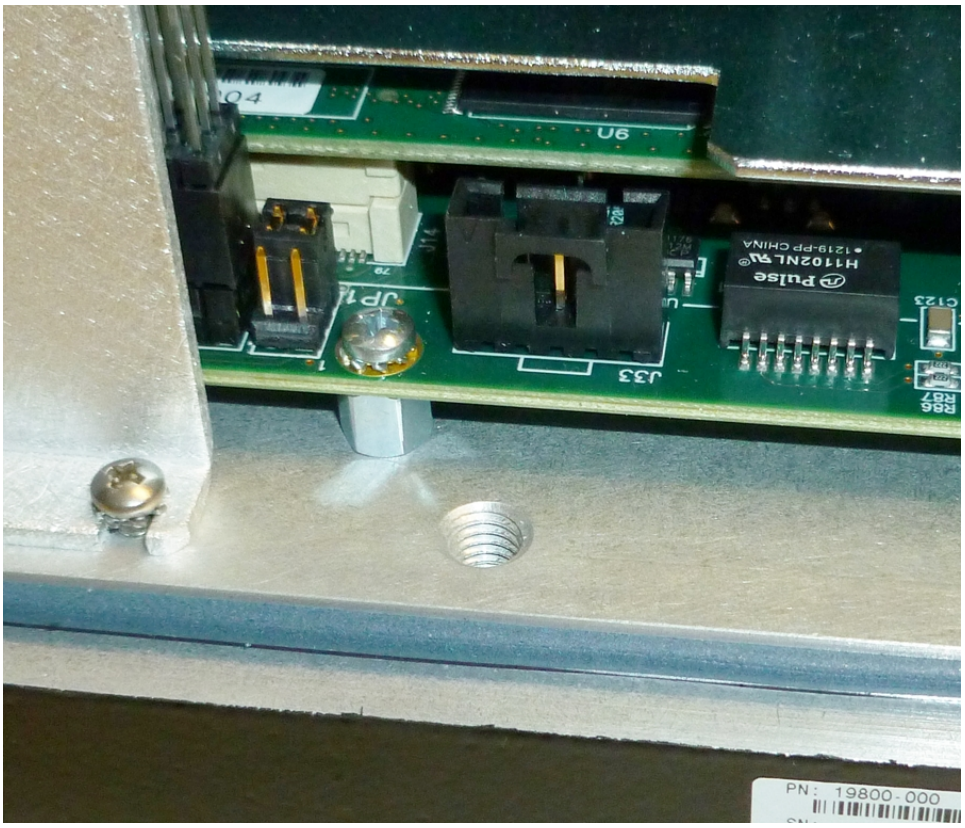


Figure 5-5. Ground Screw Hole on eAIB Chassis

12. Carefully remove the chassis from the robot, and place it aside. Tag it with the appropriate fault diagnosis faults/errors and robot serial number information.

Installing a New eAIB Chassis

1. Carefully remove the new chassis from its packaging, check it for any signs of damage, and remove any foreign packing materials or debris from inside the chassis.
2. Carefully place the chassis next to the robot.
3. Using a 5 mm hex wrench, carefully connect the ground wire to the chassis.
4. Carefully reconnect the cables you removed from their connectors on the ePMAI board, and engage the securing latches.
5. Carefully connect the "white" amplifier cable to the amplifier connector located on the chassis bracket.

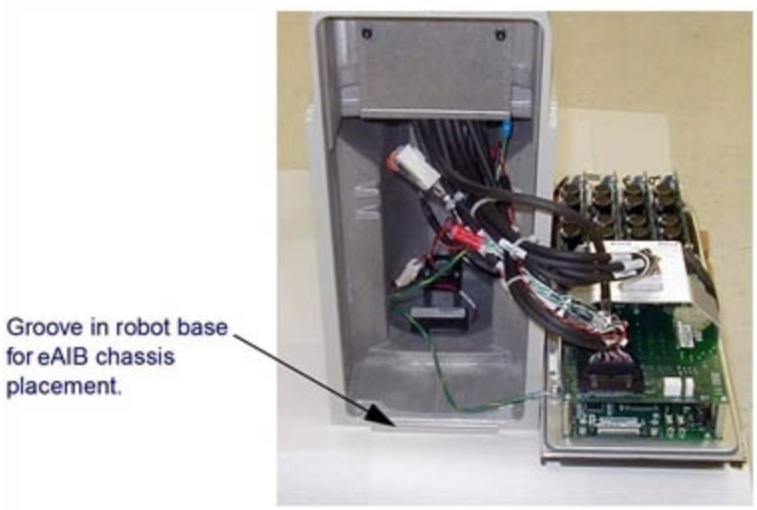


Figure 5-6. Installing eAIB Chassis in Robot Base

6. Carefully insert the chassis into the robot base in the groove at the bottom of the base—see Figure 5-6. Tilt the chassis up and into place against the robot, making sure that none of the cables get trapped or pinched and that the chassis O-ring is not damaged during installation.
7. Once the chassis is in place, use a 5 mm hex wrench to tighten the chassis securing screw. See Figure 5-2 for details.
8. Connect the 200/240 VAC supply cable to the chassis AC input connector.
9. Connect the eAIB XSYSTEM cable to the chassis XSYSTEM connector.
10. Connect any other cables that were connected to the chassis, such as Ethernet.
11. Connect the 24 VDC supply cable to the chassis +24 VDC input connector.
12. Switch on the 200/240 VAC input supply to the chassis.
13. Switch on the 24 VDC input supply to the chassis.
14. Once the system has completed booting, test the system for proper operation.

5.8 Commissioning a System with an eAIB

Commissioning a system involves synchronizing the robot with the eAIB.

> **NOTE**: This section only applies to robots that have an eAIB amplifier. A robot with an AIB amplifier does not need the Adept ACE commissioning.

For a new system with an eAIB, the robot and the eAIB will have been commissioned at the factory and should not need commissioning.

If you are replacing an AIB with an eAIB, you will need to commission the system.

In rare cases with a new robot with an eAIB, you may need to commission the system.

- If the system will not power up, and the robot status display shows SE, you need to commission the system.
- If the system will not power up in Manual mode, and the robot status display shows TR, you need to commission the system.

Safety Commissioning Utilities

The Adept eAIB adds two functions that implement safety in hardware:

- E-Stop

  This serves as a backup to the standard software E-Stop process. The system will always try to stop the robot using the software E-Stop first. The hardware E-Stop will take over in the event of a failure of the software E-Stop.

- Teach Restrict

  This limits the maximum speed of the robot when it is operated in Manual mode. As with the E-Stop, this is a hardware backup to software limits on robot speed. If the software fails to limit the robot speed during manual operation, the hardware Teach Restrict will disable power to the system.

These two functions are only in the eAIB amplifiers. They were not implemented in hardware in the AIB amplifiers, so these utilities do not apply to those amplifiers.

These two functions are supported by four wizards:

- E-Stop Configuration

  This sets the E-Stop hardware delay to factory specifications.

- E-Stop Verification

  This verifies that the hardware E-Stop is functioning correctly.

- Teach Restrict Configuration

  This sets the hardware Teach Restrict maximum speed to factory specifications.

- Teach Restrict Verification

  This verifies that the hardware Teach Restrict is functioning correctly.

The initial utility screen will tell you which functions are commissioned. If a function is not commissioned, its verification wizard will not be displayed. Any displayed verification wizard can be run at any time, to ensure that its function is working properly.

Prerequisites

- The robot must be set up and functional.
- The robot must use eAIB amplifiers.

  The AIB amplifiers do not support these hardware functions, and these wizards will not run.

- Adept ACE software must be installed.
- The Front Panel keyswitch must be in Auto mode.

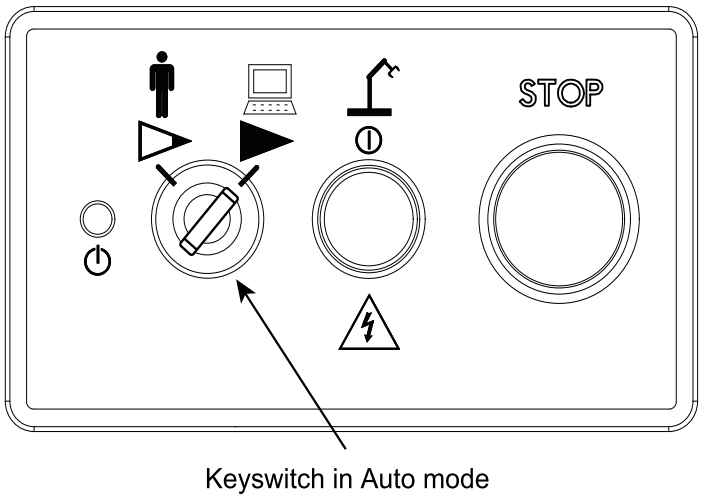


Figure 5-7. Adept Front Panel

- No E-Stops can be activated.
- For Configuration (E-Stop and Teach Restrict), the eAIB Commissioning Jumper must be plugged into the XBELTIO jack on the eAIB.

  NOTE: This is the only time that this jumper will be used. It is part number 11901-000, and must be removed for Verification and normal operation.

Figure 5-8. eAIB Commissioning Jumper

- An Adept pendant is required for the Teach Restrict verification.

E-Stop Configuration Utility

This utility sets the E-Stop hardware delay to factory specifications.

NOTE: Ensure that the commissioning jumper is plugged into the XBELTIO jack on the eAIB before you start this procedure.

Procedure

From within the Adept ACE software:

1. Open the robot object editor.
2. Select **Configure > Safety Settings > Configure ESTOP Hardware Delay**, then click Next.

   This procedure will configure Channel A and then Channel B.
   It will then report the delay that it set for each.
3. Reboot the robot controller.
4. Reboot the eAIB.

E-Stop Verification Utility

This utility verifies that the hardware E-Stop parameters are set correctly and that the hardware E-Stop is working.

The hardware E-Stop must have already been configured for this wizard to run.

> **NOTE**: If the commissioning jumper is plugged into the XBELTIO jack on the eAIB, remove it before you start this procedure.

Procedure

From within the Adept ACE software:

1. Open the robot object editor.
2. Select **Configure > Safety Settings > Verify ESTOP Hardware Delay**, then click Next.
3. Enable high power, if not already enabled, then click Next.
4. Press an E-Stop button (on the Front Panel), then click Next.

   The utility will confirm that the hardware delay has been verified for this robot, and display the delay times for channels A and B.
5. Reboot the robot controller.

Teach Restrict Configuration Utility

This utility sets the hardware Teach Restrict maximum speed parameter to factory specifications.

> **NOTE**: Ensure that the commissioning jumper is plugged into the XBELTIO jack on the eAIB before you start this procedure.

Procedure

> **NOTE**: This procedure takes 2 or 3 minutes to complete.

From within the Adept ACE software:

1. Open the robot object editor.
2. Select **Configure > Safety Settings > Configure Teach Restrict**, then click Next.
3. From the Prerequisite screen, click Next.

   The wizard will go through all of the robot's motors, and display messages that it is configuring Channel A and B for each.

   It will then record the configuration, and display the target times that it set.
4. Click Finish.
5. Reboot the robot controller.

Teach Restrict Verification Utility

This utility verifies that the Teach Restrict parameters are set correctly and that the hardware Teach Restrict maximum speed control is working.

This is a two-part wizard. The first is run in Auto mode. The second is run in Manual mode.

Before running this verification utility, the Teach Restrict must be configured.

> **NOTE**: If the commissioning jumper is plugged into the XBELTIO jack on the eAIB, remove it before you start this procedure.

Automatic Mode Procedure

WARNING: The robot will move during this wizard. Ensure that personnel stay clear of the robot work area.

From within the Adept ACE software:

1. Open the robot object editor.
2. Select **Configure > Safety Settings > Verify Teach Restrict**, then click Next.
3. Teach a Start Position.

   This can be any position that does not conflict with obstacles or the limits of joint movements.

   - If the robot is already in such a position, you can just click Next.
   - Otherwise, move the robot to such a position, then click Next.
   - The screen will display the number of degrees that each joint is expected to move during the verification process.
   - You can click Preview Motions on this screen to view the motions at slow speed. The default speed is 10, but you can change that speed with this screen's speed control.
   - You can click Move to Ready, to move the robot to the Ready position.

The robot will move each joint, in succession. It will generate an over-speed condition for each, and verify that the hardware detected the over-speed condition.

4. Click Next, to proceed to the Manual Mode Procedure.

   If the Automatic Mode Procedure fails, you will not be allowed to proceed with the Manual Mode.

Manual Mode Procedure

The manual mode of this verification requires the use of an Adept pendant.

For this verification, the Front Panel keyswitch must be in Manual mode.

1. From the Introduction screen, click Next.
   - Set the pendant to Joint mode.
   - Set the pendant manual control speed to 100.
2. Click Next.
3. Using the pendant, jog any of the robot's joints until power is disabled.

   This indicates that the Teach Restrict function is working.
4. Click Next.

   The results of the verification will be displayed.
5. Click Finish.
6. Reboot the robot controller.
7. Reset the Front Panel keyswitch to Auto mode.

5.9 Replacing the Encoder Battery Pack

The data stored by the encoders is protected by a 3.6 V lithium backup battery pack located in the base of the robot.

CAUTION: Replace the battery pack only with a 3.6 V, 6.8 Ah lithium battery pack, Adept P/N 09977-000.

NOTE: The previous battery, P/N 02704-000, has been superseded by this battery pack. The battery replacement interval and procedure have not changed.

Battery Replacement Time Periods

If the robot is kept in storage and not in production, or the robot is turned off (no 24 VDC supply) most of the time, then the battery should be replaced every 5 years.

If the robot is turned on with 24 VDC supplied to the robot more than half the time, then you can increase the replacement interval to a maximum of 10 years.

NOTE: Dispose of the battery according to all local and national environmental regulations regarding electronic components.

Battery Replacement Procedure

1. Obtain the replacement battery pack.
2. Switch off the 24 VDC input supply to the robot.
3. Switch off the 200/240 VAC input supply to the robot.
4. Disconnect the 24 VDC supply cable from the robot +24 VDC input connector. For the connector location, see System Cable Diagram on page 23.
5. Disconnect the 200/240 VAC supply cable from the robot AC input connector.
6. Using a 5 mm hex wrench, carefully unscrew the eAIB chassis securing screw. See Figure 5-2. Note that the screw does not need to be completely removed in order to remove the chassis, as this screw is captured on the chassis heat sink.
7. While holding the chassis heat sink, carefully and slowly lower the chassis down, see Figure 5-3. This provides access to the battery pack, as shown in the following figure.

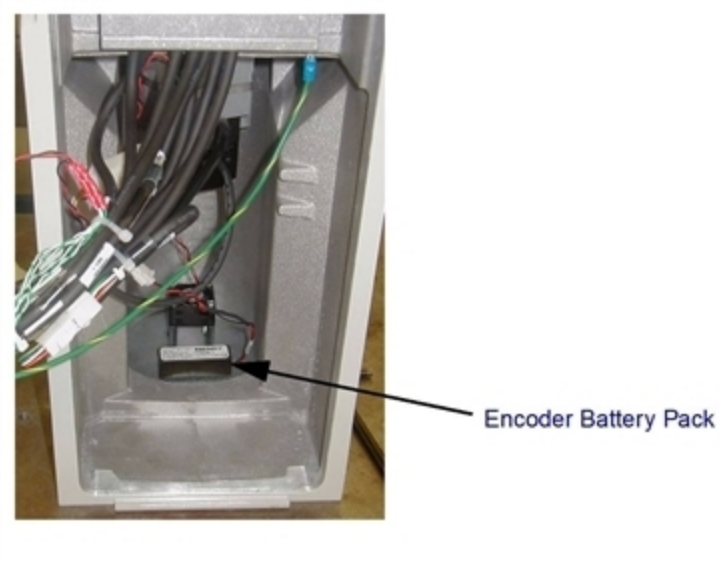


Figure 5-9. Location of Encoder Battery Pack

8. The battery cable assembly has two sets of connectors. Locate the secondary (unused) battery cable in the wire bundle in the base area.
9. Place the new battery pack next to the original one, but do not disconnect the original one.
10. Connect the new battery pack to the connectors on the secondary battery cable. Make sure to verify the positive and negative connections are correct.
11. Once the new battery pack is connected, disconnect and remove the original battery pack.

NOTE: Dispose of the battery pack in accordance with all local and national environmental regulations regarding electronic components.

12. Place the new battery pack in the original location on the base of the robot.
13. Close the robot by reversing the steps in the beginning of this procedure.
14. Reconnect the 200/240 VAC supply cable to the robot AC input connector.
15. Reconnect the 24 VDC supply cable to the robot +24 VDC input connector.

Chapter 6: Optional Equipment Installation

6.1 Installing End-Effectors

The user is responsible for providing and installing any end-effector or other end-of-arm tooling. End-effectors can be attached to the tool flange using four M6 screws. See Tool Flange Dimensions for Both Robots on page 85 for a detailed dimension drawing of the tool flange.

A 6 mm diameter x 12 mm dowel pin (user-supplied) fits in the through hole in the tool flange and can be used as a keying or anti-rotation device in a user-designed end-effector.

If hazardous voltages are present at the end-effector, you must install a ground connection from the base of the robot or the outer link to the end-effector. See Grounding Robot-Mounted Equipment on page 31.

> **NOTE:** A threaded hole is provided on the tool flange. See Tool Flange Dimensions for Both Robots on page 85. The user may attach a ground wire through the quill connecting the outer link and the tool flange.

6.2 Removing and Installing the Tool Flange

The tool flange can be removed and reinstalled. If the flange is removed, it must be reinstalled in exactly the same position to avoid losing the calibration for the system.

There is a setscrew on the flange that holds the rotational position of the flange on the quill shaft. A steel ball behind the setscrew contacts the shaft in one of the vertical-spline grooves in the shaft. Follow the procedures below to remove and reinstall the flange assembly.

Removing the Flange

1. Turn off high power and system power to the robot.
2. Remove any attached end-effectors or other tooling from the flange.
3. Use a 2.5 mm hex wrench to loosen the setscrew. See Figure 6-1. Note the vertical-spline groove that is in line with the setscrew. You must reinstall the flange in the same position.
4. Use a socket driver to loosen the two M4 socket-head screws.
5. Slide the flange down slowly until it is off the shaft. *Be careful* not to lose the steel ball (3.5 mm) that is inside the flange behind the setscrew.

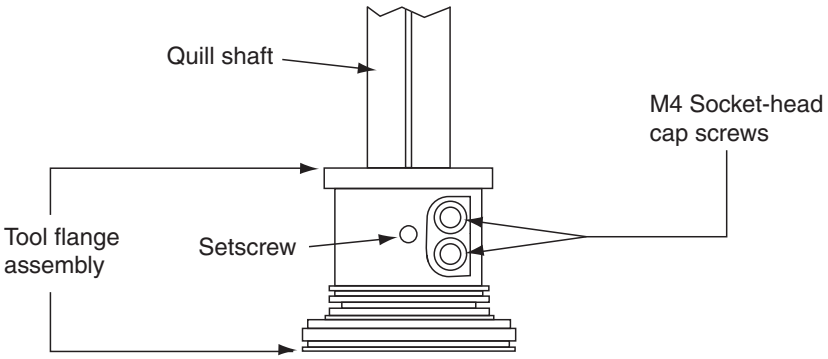


Figure 6-1. Tool Flange Removal Details

Installing the Flange

1. Make sure the steel ball is in the setscrew hole inside the flange. Hold it in place with your finger as you get ready to install the flange.
2. Slide the flange up on the quill shaft as far as it will go, and rotate until the setscrew is lined up with the original vertical groove.
3. Support the flange while using a 2.5 mm hex wrench to tighten the setscrew to finger tight. Do not over-tighten the setscrew because this will cause the flange to be off-center from the quill shaft.
4. Use a socket driver to tighten one of the socket-head screws part of the way, then tighten the other one the same amount. Alternate between the two screws so there is even pressure on both once they are tight. The torque specification for each screw is 8 N·m (70 in-lb).

6.3 User Connections on Robot

User Air Lines

There are five user air line connectors on the robot user panel on the back of Joint 1 (see Figure 6-2). The five air lines run through the robot up to another set of five matching connectors on the top of the outer link. See Figure 6-3.

- The two larger connectors are 6 mm diameter.
- The three smaller connectors are 4 mm diameter.

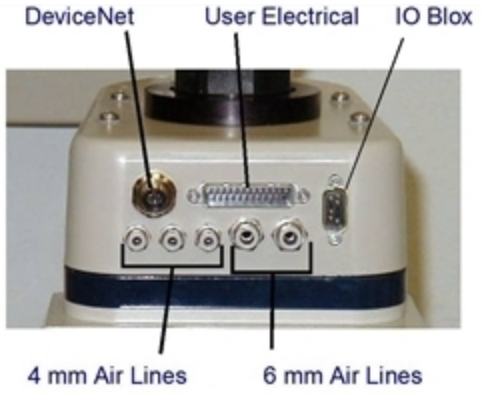


Figure 6-2. User Connectors on Joint 1

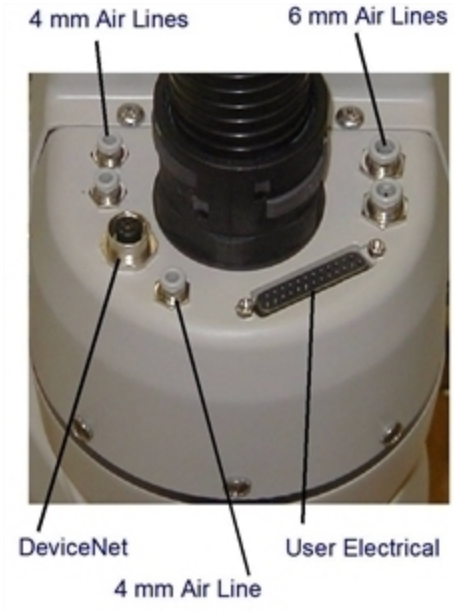


Figure 6-3. User Connectors on Joint 2

User Electrical Lines

NOTE: DeviceNet and IO Blox are not supported on the ePLC family of Cobra robots.

There is a 25-pin male connector (24 conductor) on the robot user panel on the back of Joint 1 for user electrical lines, see Figure 6-2. This connector is wired directly to a 25-pin female connector on the top of the outer link, see Figure 6-3. These connectors can be used to run user electrical signals from the user panel, through the robot, and up to the outer link.

Wire Specifications: Wire size: 0.1 mm^2, Pin Numbers 1-24, 12 pairs, twisted in pairs as 1&2, 3&4, 5&6, . . . 23&24. Maximum current per line: 1 Amp.

6.4 Internal User Connectors

The internal user connectors, OP3/4, EOAPWR, and ESTOP, can be accessed with the Outer Link cover removed—see Figure 6-4. The SOLND connector is located on the opposite of the bulkhead area—see Figure 6-5.

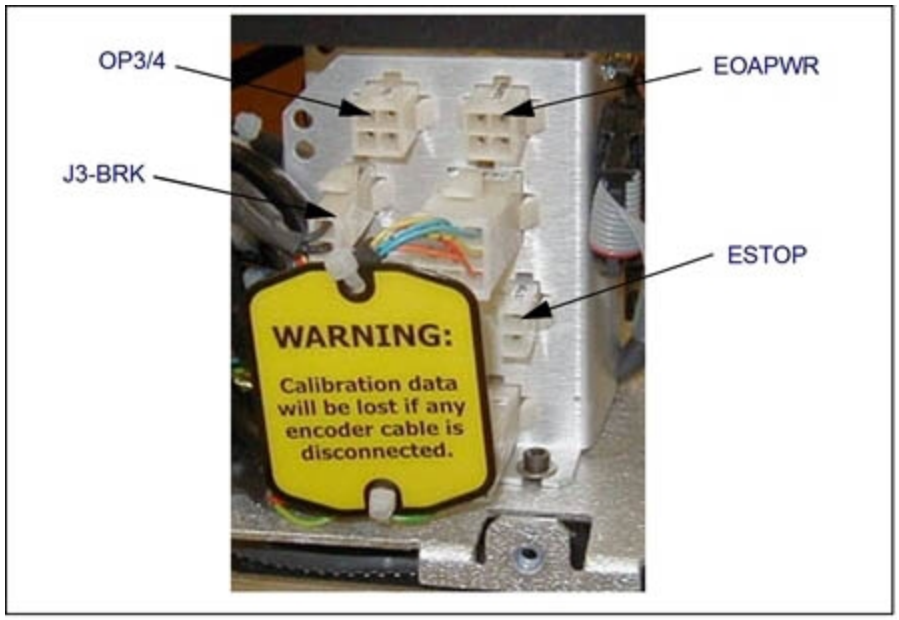


Figure 6-4. Internal User Connectors—OP3/4, EOAPWR, ESTOP

WARNING: When the Outer link cover is removed, you see the label shown above. Do not remove the J3-ENC or J4-ENC encoder cable connectors from their sockets. If they are removed, the calibration data will be lost and the robot must be run through a factory recalibration process, which requires special software and tools.

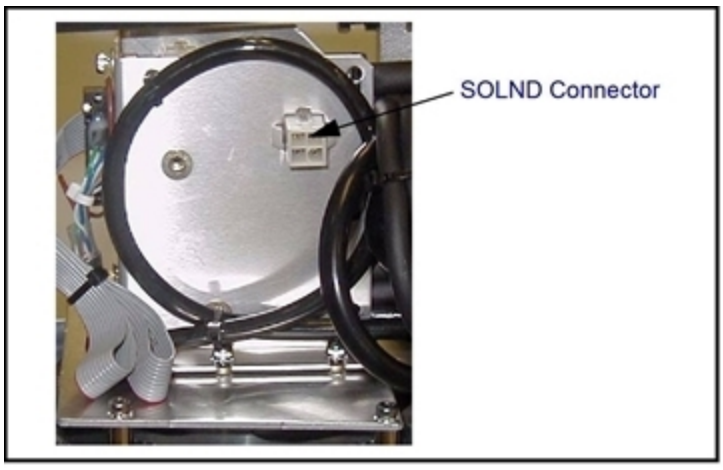
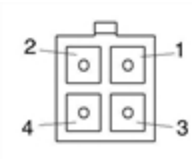


Figure 6-5. SOLND Connector

SOLND Connector

This 4-pin connector provides the output signals for the optional Robot Solenoid Kit. See the previous figure and following table. For installation details, see Installing the Robot Solenoid Kit on page 77.

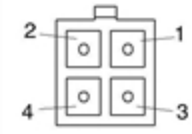
Table 6-1. SOLND Connector Pinout

Pin #	Description	Pin Location
1	Output 3001	 SOLND Connector as viewed on robot
2	Ground	
3	Output 3002	
4	Ground	
Mating Connector: AMP/Tyco #172167-1, 4-pin Mini-Universal Mate-N-Lok AMP/Tyco #770985-1, Pin Contact, Mini-Univ. Mate-N-Lok		

OP3/4 Connector

This 4-pin connector provides the output signals for a second set of optional robot hand valve solenoids, or other user-supplied devices. See the following table and figure. For the connector location, see Figure 6-4.

Table 6-2. OP3/4 Connector Pinout

Pin #	Description	Pin Location
1	Output 3003	 OP3/4 Connector as viewed on robot
2	Ground	
3	Output 3004	
4	Ground	
Mating Connector: AMP/Tyco #172167-1, 4-pin Mini-Universal Mate-N-Lok AMP/Tyco #770985-1, Pin Contact, Mini-Univ. Mate-N-Lok		

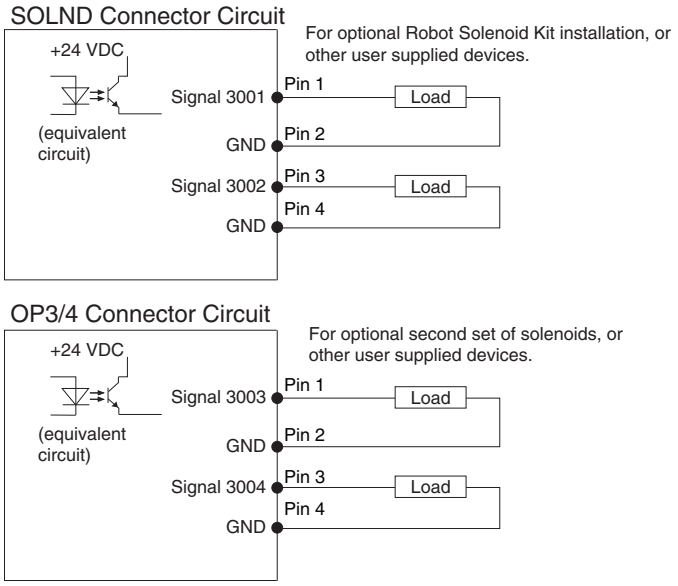
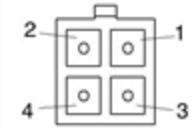


Figure 6-6. OP3/4 and SOLND Circuits

EOAPWR Connector

This 4-pin connector provides 24 VDC power and ground for user applications. See the following table for the pinouts and the following section for the output specifications. For the connector location, see Figure 6-4.

Table 6-3. EOAPWR Connector Pinout

Pin #	Description	Pin Location
1	24 VDC (see the next table for current specs)	 EOAPWR Connector as viewed on robot
2	Ground	
3	24 VDC (see the next table for current specs)	
4	Ground	
Mating Connector: AMP/Tyco #172167-1, 4-pin Mini-Universal Mate-N-Lok AMP/Tyco #770985-1, Pin Contact, Mini-Univ. Mate-N-Lok		

Internal User Connector Output Specifications

The output specifications in the following table apply to the EOAPWR, OP3/4, and SOLND internal user connectors.

Table 6-4. Internal User Connector Output Circuit Specifications

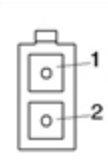
Parameter	Value
Power supply voltage range	24 VDC ± 10% See Specifications for 24 VDC Power on page 24.
Operational current range, per channel	$I_{out} \leq$ 700 mA
Total Current Limitation, all channels on[a]	$I_{total} \leq$ 1.0 A @ 50° C ambient $I_{total} \leq$ 1.5 A @ 25° C ambient
On-state resistance (I_{out} = 0.5 A)	$R_{on} \leq$ 0.32 Ω @ 85° C
Output leakage current	$I_{out} \leq$ 25 µA
Turn-on response time	125 µsec. max., 80 µsec typical (hardware only)
Turn-off response time	60 µsec. max., 28 µsec typical (hardware only)
Output voltage at inductive load turnoff (I_{out} = 0.5 A, Load = 1 mH)	(+V - 65) ≤ $V_{demag} \leq$ (+V - 45)
DC short circuit current limit	0.7A ≤ $I_{LIM} \leq$ 2.5 A
Peak short circuit current	$I_{ovpk} \leq$ 4 A
[a]**NOTE:** Total current is the sum of the output current used by output signals 3001-3004 (SOLND and OP3/4) and any user current drawn from EOAPWR.	

ESTOP Connector

The Break-away E-STOP function is provided to enable a high power shutdown from the outer link area. For example, it would be used if you want a break-away gripper to shut down robot high power. It lets you disable high power through a user relay circuit inside the robot.

The 2-pin ESTOP connector provides a pair of contacts that can be used for a Break-away E-Stop function at the end of the arm. See the following table. The function is disabled by default when the system is shipped. The user must enable this function using the Adept ACE software (see below), and connect a normally-closed circuit to Pins 1 and 2. When the circuit is opened, the system will stop in an E-Stop condition. See the following table and figure.

Table 6-5. ESTOP Connector

Pin #	Description	Pin Location
1	ESTOP_INPUT	 ESTOP Connector as viewed on robot
2	24 V	
Mating Connector: AMP/Tyco #172165-1, 2-pin Mini-Universal Mate-N-Lock AMP/Tyco #770985-1, Pin Contact, Mini-Univ. Mate-N-Lok		

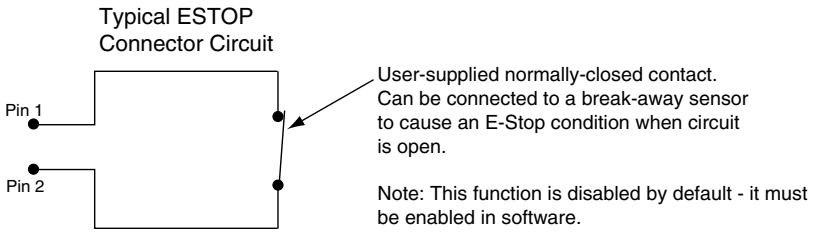

Typical ESTOP
Connector Circuit
Pin 1
Pin 2
User-supplied normally-closed contact.
Can be connected to a break-away sensor
to cause an E-Stop condition when circuit
is open.
Note: This function is disabled by default - it must
be enabled in software.

Figure 6-7. Internal E-Stop Connector Circuit

NOTE: This circuit will trigger an emergency stop of the local robot only. It does not link to the E-Stop chain.

Procedure to Enable the Break-away E-Stop Function

To enable the Break-away E-Stop function, you have to use the Adept ACE software to change the default configuration:

NOTE: When the Break-away E-Stop function has been enabled, you must connect a normally-closed circuit to pins 1 and 2 of the ESTOP connector, as described above. If this is not done, the system will be in an E-Stop condition and you will not be able to enable power.

6.5 Mounting Locations for External Equipment

Three locations are provided for mounting user's external equipment on the robot arm. The first location is on the J1 Harness Support (top side of the inner link), a second is on the top side of the outer link, and a third is on the bottom side of the outer link. Each location has a set of four tapped holes. See External Tooling on Top of Robot Arm on page 86 and External Tooling on Underside of Outer Link on page 86 for the dimensions.

NOTE: The cover on the outer link must be removed for maintenance (lubrication), so keep this in mind when mounting any external equipment to the outer link cover.

6.6 Installing the Robot Solenoid Kit

This procedure describes how to mount the 24 V Robot Solenoid option on Adept Cobra ePLC600 and ePLC800 robots. The kit is available as Adept P/N 02853-000.

The robot has been pre-wired to accommodate a bank of two 24 VDC solenoid valves. Power for the internal mounting is accessible via a connector mounted inside the outer link cover (see Figure 6-8). The signals actuating the valves are set in the eAIB, by default, to 3001 to 3004.

The Adept-supplied solenoids each draw a nominal 75 mA from 24 VDC.

The solenoid valve assembly consists of two independent valves (Valve #1 and Valve #2) on a common manifold. The manifold supplies air at the user's line pressure: minimum 28 psi (0.19 MPa), to maximum 114 psi (0.786 MPa). Each valve has two output ports, A and B. The output ports are arranged so that when Port A is pressurized, Port B is not pressurized. Conversely, when Port B is pressurized, Port A is not. In the Adept Cobra ePLC robots, the air lines from Port A on each valve are plugged at the factory (at the solenoid assembly).

The Solenoid Kit for the Adept Cobra ePLC600/800 robots is available through Adept. Contact your Adept Sales Representative for current price and availability.

Table 6-6. Air Pressure

Air Pressure (Psi)	Air Pressure (MPa)
28 - 114	0.19 - 0.786

Tools Required

- Hex drivers
- Cable ties
- Diagonal wire cutters
- Solenoid Valve upgrade Kit (Adept P/N 02853-000)

Procedure

1. Turn off all power to the robot.
2. Remove two screws on ePLC600 (three screws on ePLC800) on each side of the outer link cover. Remove two screws on top and remove the cover.
3. Connect the Internal Solenoid Valve Cable assembly to the Solenoid Manifold assembly, by plugging the SOL 1 connector into Valve 1 and SOL 2 into Valve 2.

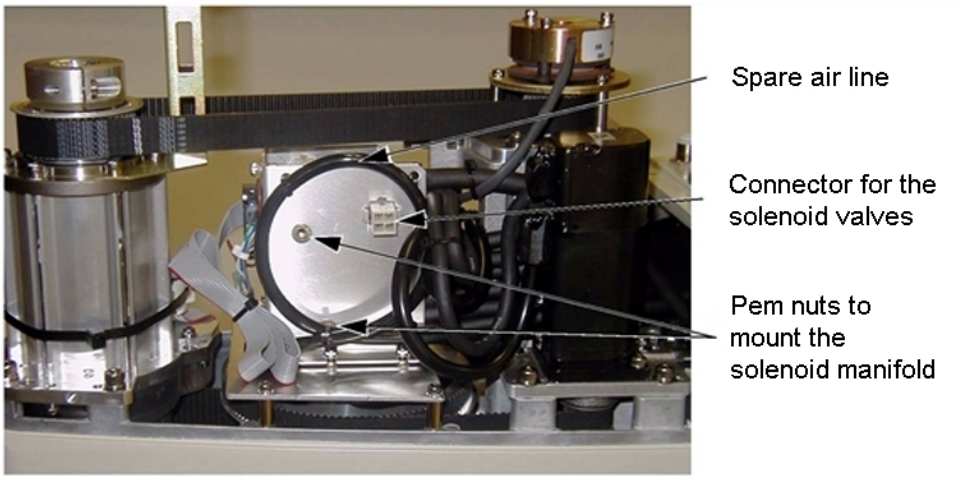


Figure 6-8. Solenoid Mounting Bracket With Connector and Spare Air Line

4. Cut and discard the cable ties holding the spare air line at the top of the mounting bracket. Move the air line away to facilitate the mounting of the solenoid manifold. See Figure 6-8.
5. Mount the solenoid manifold onto the bracket using the supplied M3 x 25 mm screws and washers. See Figure 6-9.
6. Insert the spare air line into the air intake coupling of the solenoid manifold. Make sure the air line is pushed in all the way and secured in place by the intake coupling. Confirm by gently pulling the air line.

   NOTE: If you are installing on a Cleanroom or IP-65 robot, the spare air line is used for a different purpose in those robots. You will have to provide a piece of 6 mm tubing to run from one of the 6 mm user air lines at the Joint 2 cover to the air intake coupling mentioned above.

7. Plug the connector plug into the female connector jack (marked SOLND) on the bracket.
8. Use cable ties to secure air line to the bracket as needed.

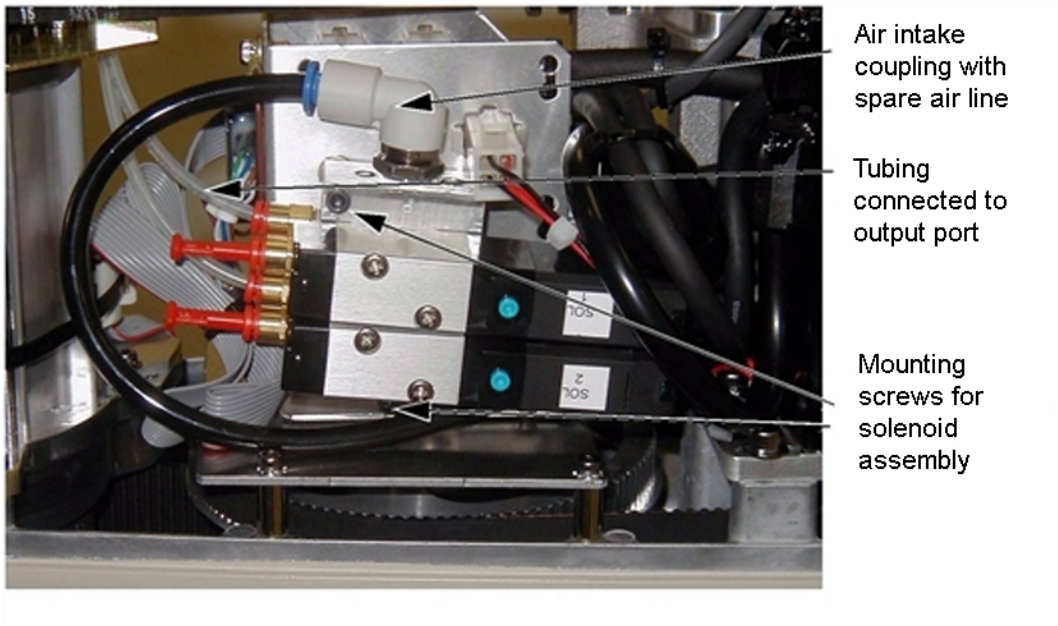


Figure 6-9. Solenoid Placement Using Mounting Hardware

9. Install the appropriate lengths of 5/32 inch plastic tubing (supplied) into the two output ports on the manifold.
    - Route the tubing up along the tower bracket next to the quill and down through the center of the quill.
    - Use cable ties as needed to secure the tubing.
10. Loosen the securing screw on the eAIB chassis, and lower the chassis down flat. See for the location of the securing screw.
11. Remove the cable strap plate by removing two screws and split washers. See Figure 6-10. This allows the harness to move when you lift the J1 cover in the next step.

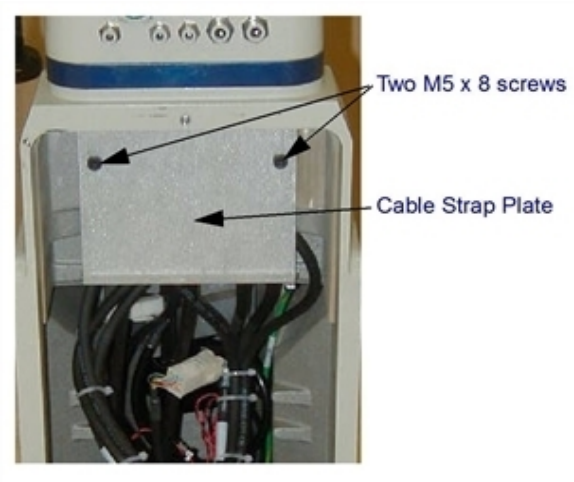


Figure 6-10. Removing the Cable Strap Plate

12. Remove the four screws for the Joint 1 cover and lift the cover up so you have access to the tubing under the cover. See Figure 6-11.

Joint 1 cover lifted to access spare air line
User Air fitting for connecting spare line. Remove factory installed tubing first.
Tubing bundle containing spare air line

Figure 6-11. Connecting Spare Air Line to User Connector

13. Disconnect the tubing from the 6 mm User Air fitting shown in Figure 6-11. Fold the tubing out of the way and restrain using tie-wraps.
14. Locate the spare air line contained in the tubing bundle inside the front end of the cover. Remove the spare air line from the bundle.
15. Insert the spare air line into the back of the empty 6 mm User Air fitting.

NOTE: This 6 mm User Air connector and the 6 mm User Air connector at the top of Figure 6-2 are not available for other uses after this modification.

16. Reinstall the Joint 1 cover, taking care to ensure that all tubing is inside the cover and nothing gets crimped or pinched while pushing the cover into position. Reinstall four screws to secure the cover. Tighten the screws to 1.6 N·m (14 in-lb) of torque.
17. Reinstall the cable strap plate that you removed earlier in the procedure.
18. Raise the eAIB chassis to the closed position and tighten the securing screw.
19. Reinstall the outer link cover and tighten the screws to 1.6 N·m (14 in-lb) of torque.
20. Connect the factory air supply to the 6 mm User Air connector.

    For the non-IP-65 robot, this is the air connector just modified.
21. Select Signal 3001 and Signal 3002 to activate the solenoids one at a time.

WARNING: Disconnect robot air pressure until this test has been done to prevent unsecured pneumatic lines from accidentally injuring personnel.

Chapter 7: Technical Specifications

7.1 Dimension Drawings

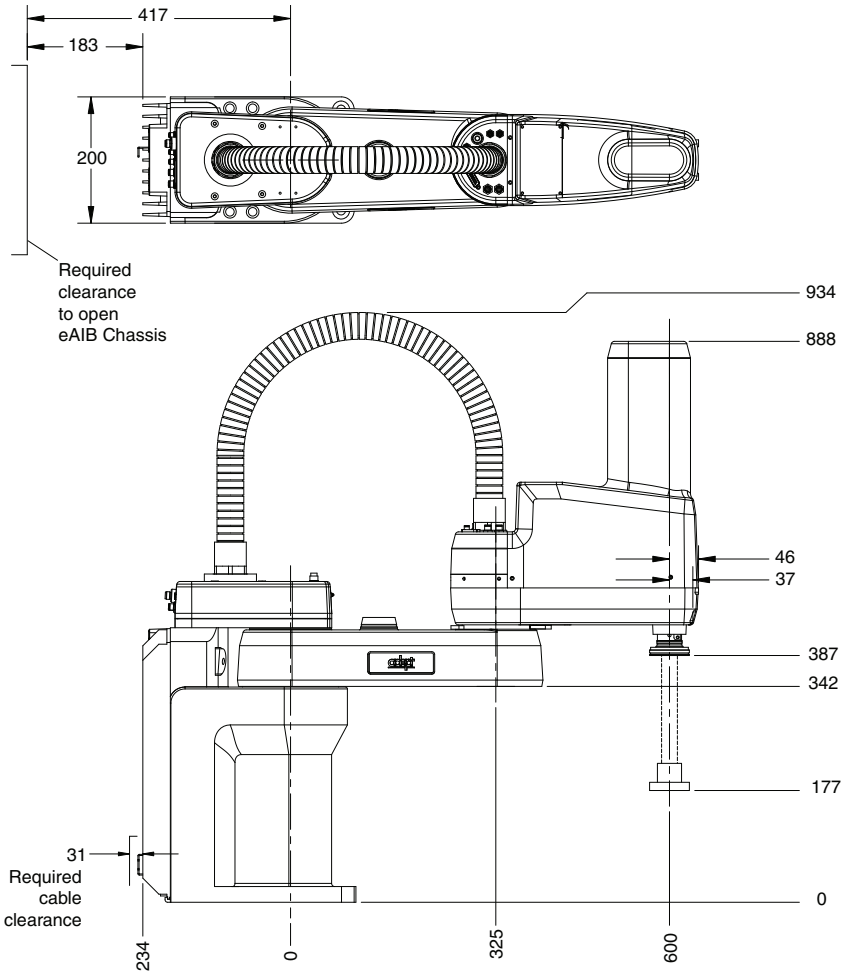


Figure 7-1. Adept Cobra ePLC600 Robot Top and Side Dimensions

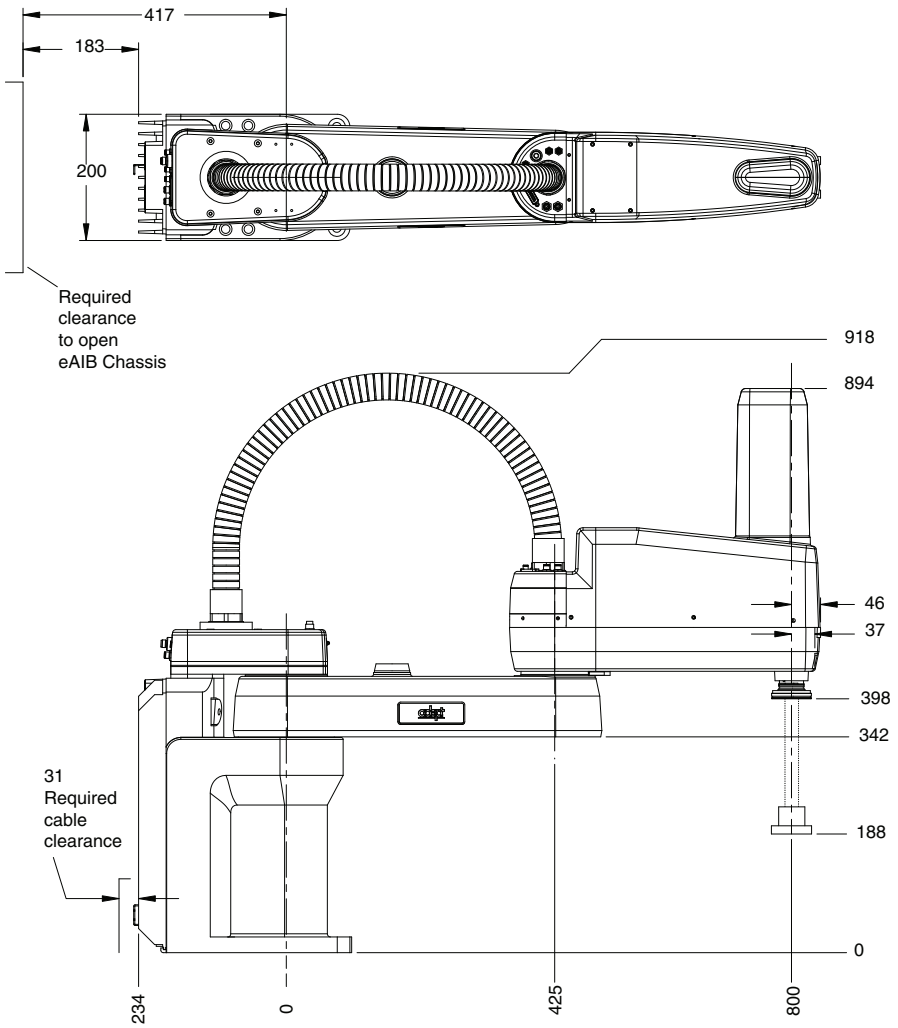


Figure 7-2. Adept Cobra ePLC800 Robot Top and Side Dimensions

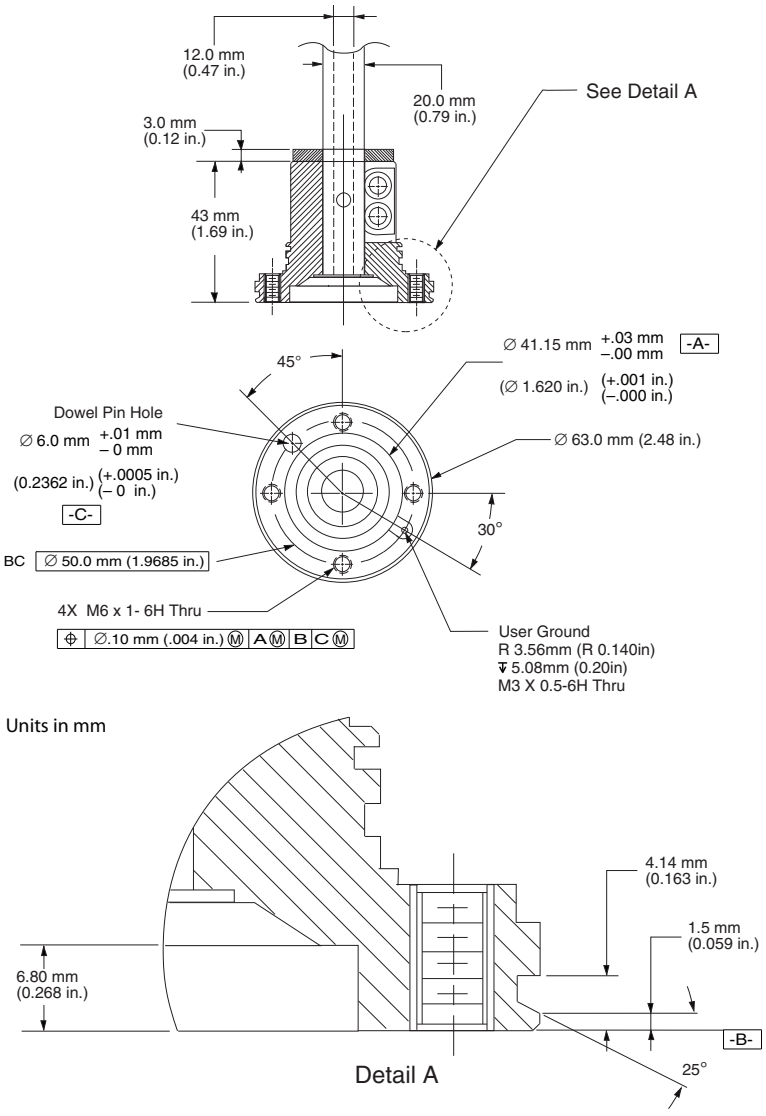


Figure 7-3. Tool Flange Dimensions for Both Robots

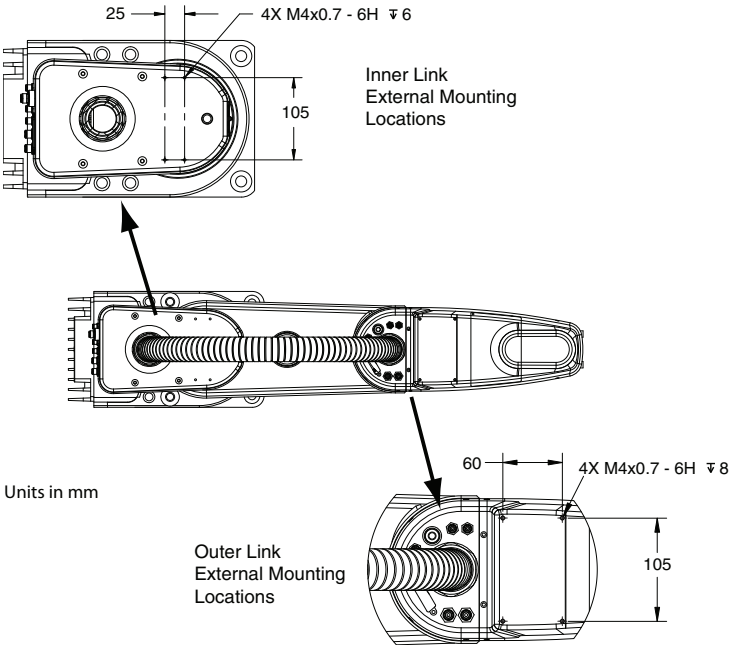


Figure 7-4. External Tooling on Top of Robot Arm

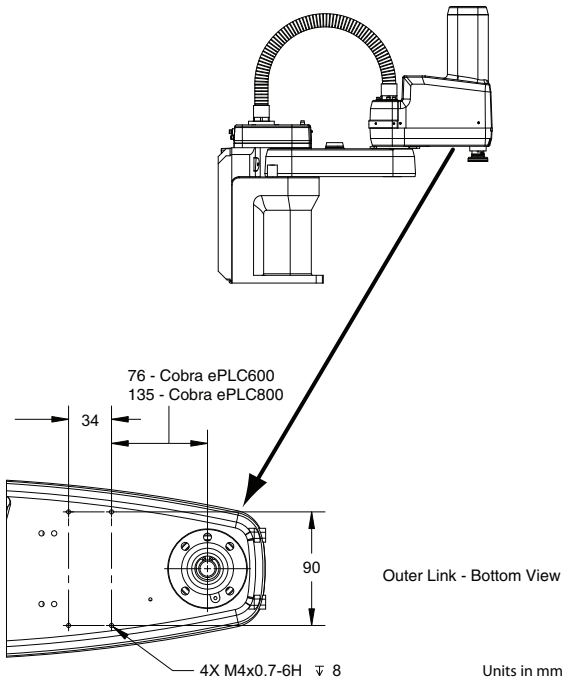


Figure 7-5. External Tooling on Underside of Outer Link

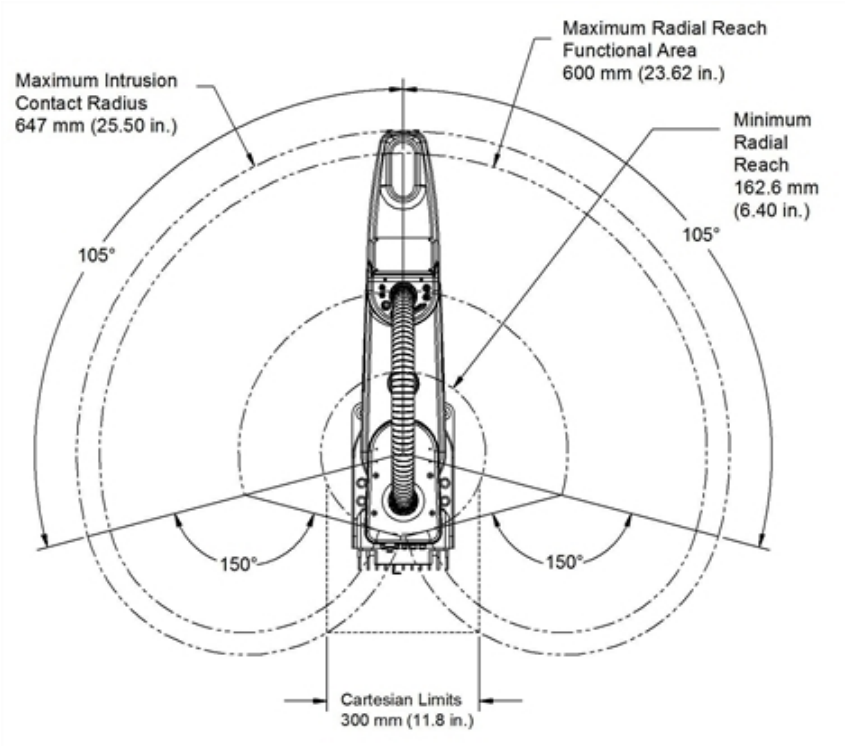


Figure 7-6. Adept Cobra ePLC600 Robot Working Envelope

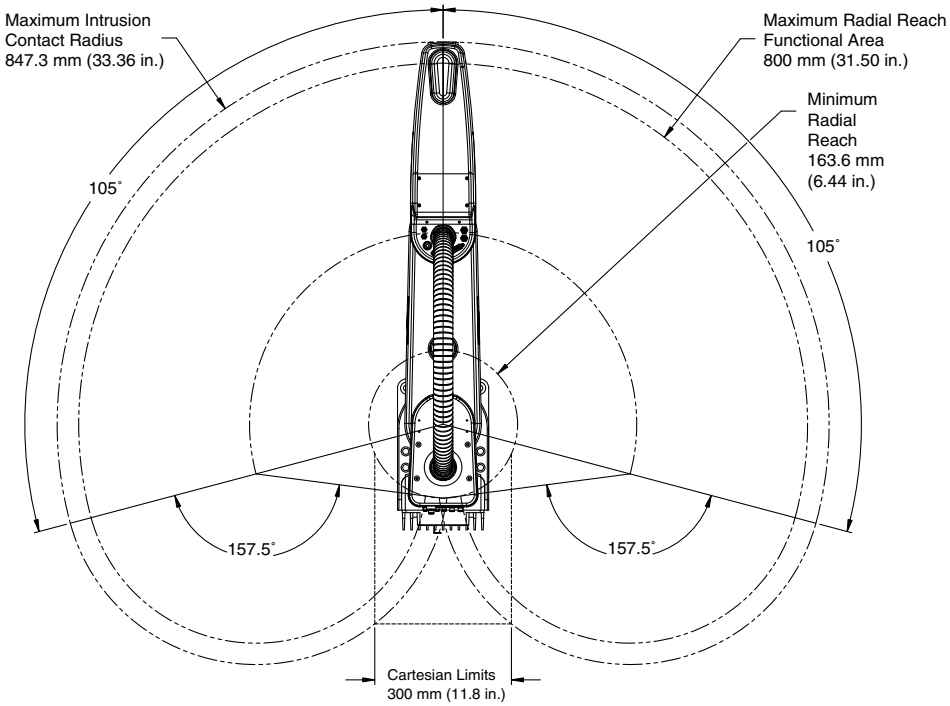


Figure 7-7. Adept Cobra ePLC800 Robot Working Envelope

7.2 Robot Specifications

Description	ePLC600 Robot	ePLC800 Robot
Reach	600 mm (23.6 in)	800 mm (31.5 in)
Payload—rated	2.0 kg (4.4 lb)	2.0 kg (4.4 lb)
Payload—maximum	5.5 kg (12.1 lb)	5.5 kg (12.1 lb)
Moment of Inertia	Joint 4 - 450 kg-cm^2 (150 lb-in^2) - max	Joint 4 - 450 kg-cm^2 (150 lb-in^2) - max
Downward Push Force—Burst, (no load)	343 N (77 lb) - maximum	298 N (67 lb) - maximum
Lateral/Side Push Force—Burst	178 N (40 lb) - maximum	133 N (30 lb) - maximum
Adept Cycle—Sustained (no J4 rotation)		
0 kg	0.42 sec at 20° C 0.48 sec at 40° C	0.48 sec at 20° C 0.51 sec at 40° C
2 kg	0.45 sec at 20° C 0.51 sec at 40° C	0.54 sec at 20° C 0.54 sec at 40° C
5.5 kg	0.58 sec at 20° C 0.64 sec at 40° C	0.70 sec at 20° C 0.70 sec at 40° C
Adept Cycle—Sustained (180° J4 rotation)		
0 kg	0.42 sec at 20° C 0.48 sec at 40° C	0.48 sec at 20° C 0.48 sec at 40° C
2 kg	0.45 sec at 20° C 0.51 sec at 40° C	0.54 sec at 20° C 0.61 sec at 40° C
5.5 kg	0.80 sec at 20° C 0.86 sec at 40° C	0.77 sec at 20° C 0.91 sec at 40° C
Repeatability		
X, Y	±0.017 mm (±0.00067 in.)	±0.017 mm (±0.00067 in.)
Z	±0.003 mm (±0.00012 in.)	±0.003 mm (±0.00012 in.)
Theta	±0.019°	±0.019°
Joint Range		
Joint 1	±105°	±105°
Joint 2	±150°	±157.5°
Joint 3	210 mm (8.3 in.)	210 mm (8.3 in.)
Joint 4	±360°	±360°
Joint Speed (maximum)		

Description	ePLC600 Robot	ePLC800 Robot
Joint 1	386°/sec	386°/sec
Joint 2	720°/sec	720°/sec
Joint 3	1,100 mm/sec (43 in/sec)	1,100 mm/sec (43 in/sec)
Joint 4	1200°/sec	1200°/sec
Encoder type	Absolute	
Robot Brakes	Joints 1, 2, and 4: Dynamic	
	Joint 3: Electric	
Airline pass-through (quantity)	6 mm diameter (2), 4 mm diameter (3)	
Electrical pass-through	24 conductors (12 twisted pair)	
Weight (without options)	41 kg (90 lb)	43 kg (95 lb)
[a]Specifications subject to change without notice.		

Table 7-1. Softstop and Hardstop Specifications

Joint	Cobra ePLC600		Cobra ePLC800	
	Softstop	Hardstop – Approximate	Softstop	Hardstop – Approximate
Joint 1	± 105	± 108	± 105	± 108
Joint 2	± 150	± 151	± 157.5	± 160
Joint 3	0 to 210 mm	-5 to 215 mm	0 to 210 mm	-5 to 215 mm
Joint 4	± 360	not applicable	± 360	not applicable

Chapter 8: IP-65 Option

8.1 Adept Cobra ePLC800 Robot IP-65 Classification

The factory installed IP-65 option kit provides an improved level of dust and water protection. IP-65 means "dust-tight and protection against water jetting."

- Dust Resistance—protection of the equipment inside the robot shell against ingress of solid foreign objects
- Specifically for IP-65 Dust Protection—"No ingress of dust is allowed."
- Water Resistance—protection of the equipment inside the robot shell against harmful effects due to the ingress of water
- Specifically for IP-65 Water Protection—"Water projected in jets against the robot enclosure from any direction shall have no harmful effects"

NOTE: The IP-65 Option is available only for the Adept Cobra ePLC800 Robot.

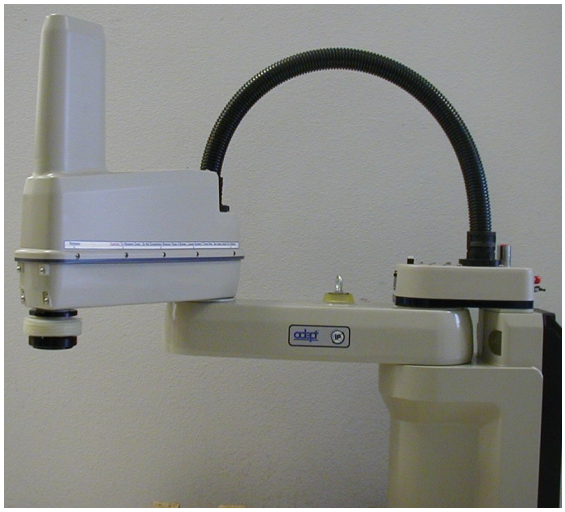


Figure 8-1. Adept Cobra ePLC800 Robot—IP-65 Version

8.2 Installing Cable Seal Assembly

Cable Seal Identification

The cable seal assembly (04813-000) must be mounted on the back of the robot during the robot installation process. The cable seal assembly is shipped separately from the robot. See the following figure to identify the cable seal parts.

Cable Seal Housing

Figure 8-2. Cable Seal Parts

Installation Procedure

1. Disassemble the cable seal assembly into separate pieces by removing all screws.
2. Install the cable seal housing on the back of the robot using four M4x50 screws, four M4 lock washers, and four M4 flat washers. Note that the centered M6 threaded hole must be at the top. See the following figure.

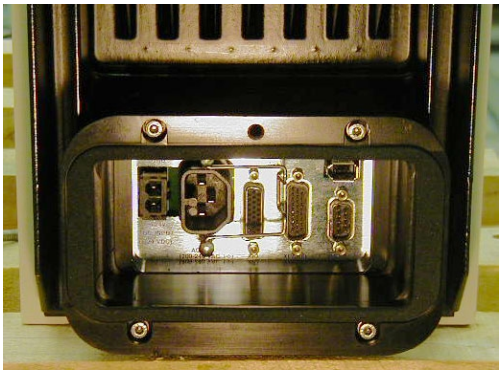


Figure 8-3. Cable Seal Housing Installed

3. Attach all system cables to the robot. See System Cable Diagram on page 23.
4. Install the lower cable seal flange onto the housing. The lower flange fits into the groove at the bottom of the housing.
    a. Tilt the flange away from the robot as you install it—see the following figure.
    b. Then pull up on the flange and push it toward the robot.

c. Finally push down on the flange to secure it against the housing. See Figure 8-5 for the lower flange in the installed position.

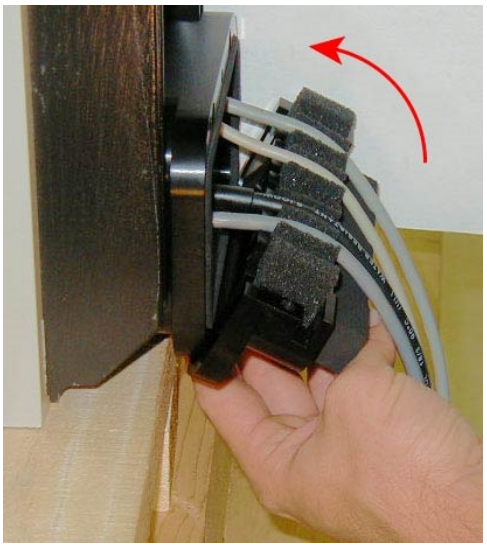


Figure 8-4. Installing Lower Flange

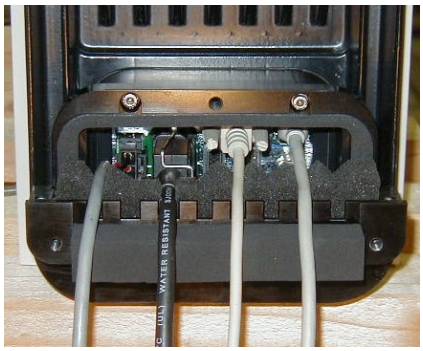


Figure 8-5. Lower Flange in Position

5. Seat all of the cables by pushing down into the foam on the lower flange.
6. Attach the upper flange to the lower flange using two M6 x 20 screws, two M6 lock washers, and two M6 flat washers. Make sure none of the cable are pinched or crimped when installing the upper flange.
7. Attach the flange assembly using one M6 x 20 screw, one M6 lock washer, and one M6 flat washer. See Figure 8-6.

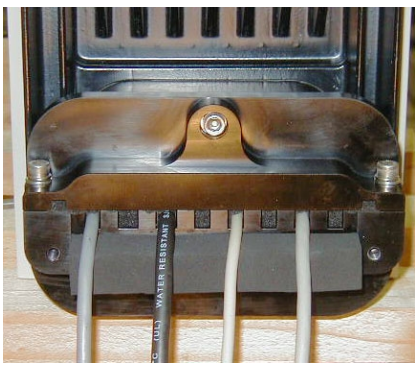


Figure 8-6. Upper Flange Installed

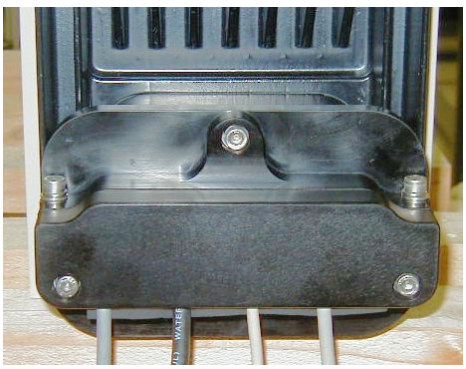


Figure 8-7. Splash Guard Installed

8. Install the splash guard using two M6 x 20 screws, two M6 lock washers, and two M6 flat washers. See Figure 8-7.

8.3 Robot Outer Link Cover Removal and Reinstallation

The robot outer link cover has special sealing hardware to ensure nothing can enter the inside of the robot. If you need to remove the outer link cover from the robot for any reason, follow the procedures below.

Cover Removal Procedure

1. Turn off main power to the power chassis.

   Lock out and tag out power.

2. Turn off the air supply to the robot. Clean the exterior of the outer link thoroughly to remove any dust or particles that might fall inside the robot when the cover is removed.

3. Unscrew the collar nut on the top of the outer link. See Figure 8-8.

4. Remove 2 screws and nylon washers on the top of the outer link.

5. Remove 2 screws (one on each side) at the front of the outer link. Make sure the O-ring on each screw stays in place and is not lost.

6. For the 8 screws along the side of the cover (4 on each side; see Figure 8-8), loosen only 1 to 2 turns, just enough to loosen the inside clamp nuts. You do not want to completely remove the screws. See the label on the side of the outer link cover.

CAUTION: Do not loosen these screws any more than 2 turns, because the special clamp nut on the inside of the cover might come loose and fall inside the robot.

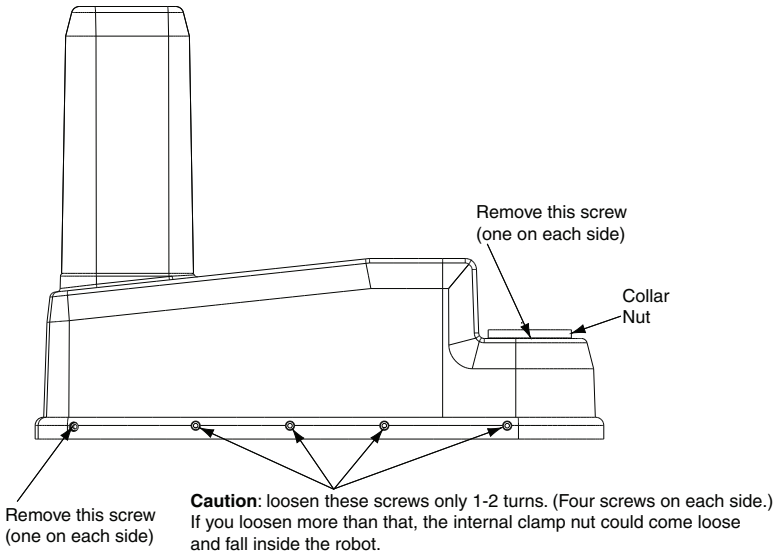

Remove this screw
(one on each side)
Collar
Nut
Remove this screw
(one on each side)
Caution: loosen these screws only 1-2 turns. (Four screws on each side.)
If you loosen more than that, the internal clamp nut could come loose
and fall inside the robot.

Figure 8-8. Cover Removal Instructions

7. When all 8 screws are loose (but not removed), lift the cover up and slide it back along the cable track and out of the way. Protect the cover with a soft cloth or other padding material so the cover does not get scratched. See Figure 8-9.

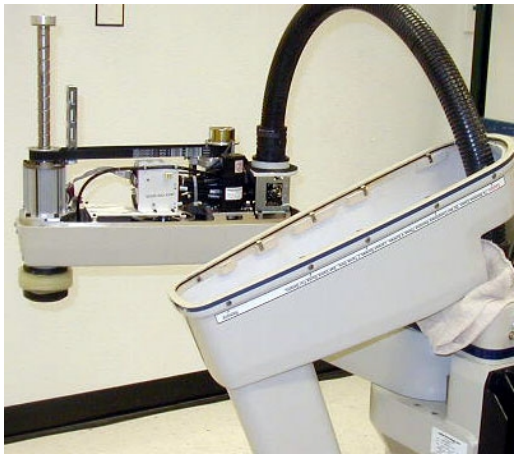


Figure 8-9. IP-65 Robot with Outer Link Cover Removed

Cover Reinstallation Procedure

1. Check the cover O-ring around the inner groove of the cover to make sure it is in place and not crimped when installing cover.
2. Hold the cover over the outer link and check to see that the clamp nuts attached to the 8 side screws are positioned so they will slip into place when the cover is lowered down onto the outer link.
3. Slowly lower the cover down onto the outer link, making sure the O-ring does not fall out or get pinched as the cover presses down to make the seal.

   NOTE: As you lower the cover down onto the outer link, make sure the 8 side screws are pushed all the way in, so the clamp nuts will slide into the correct position.

4. Reinstall the two screws and nylon washers at the top of the outer link and tighten to 5 in-lb (0.56 N-m).
5. Reinstall the 2 screws (check for O-ring on screw) near the front of the outer link and tighten to 10 in-lb (1.1 N-m).
6. Tighten the 8 side screws to 10 in-lb (1.1 N-m). Be careful to not over-tighten. Begin with the two screws (one on each side) at the back of the outer link, then move forward to the next two, and so on, until all eight are tightened. This pattern is recommended to achieve a balanced secure fit around the cover.
7. Reinstall the collar nut and tighten until secure.

8. Remember to turn on the compressed air supply to the system before restarting the robot.

8.4 Customer Requirements

The IP-65 robot provides most of the hardware needed to achieve an IP-65 protection level, but customers must provide a way of sealing the tool flange and pressurizing the robot through the compressed air attachment fitting (located at the top of the robot). These two requirements, sealing the tool flange and pressurizing the robot, are critical to achieving the IP-65 level of protection.

In addition, the robot must be inspected periodically to make sure these requirements are being met, as part of a periodic maintenance program.

Sealing the Tool Flange

The tool flange must be sealed so that the robot shell can be positively pressurized. The positive pressure reinforces the sealing properties of the gaskets and seals provided in the IP-65 robot.

The tool flange for the IP-65 robot has an additional protective shield on the outer edge that is not present on the standard robot tool flange. See Figure 8-10 for the side view dimensions. The bottom face of the flange (mounting surface) is the same as the standard flange, so the dimensions in are correct.

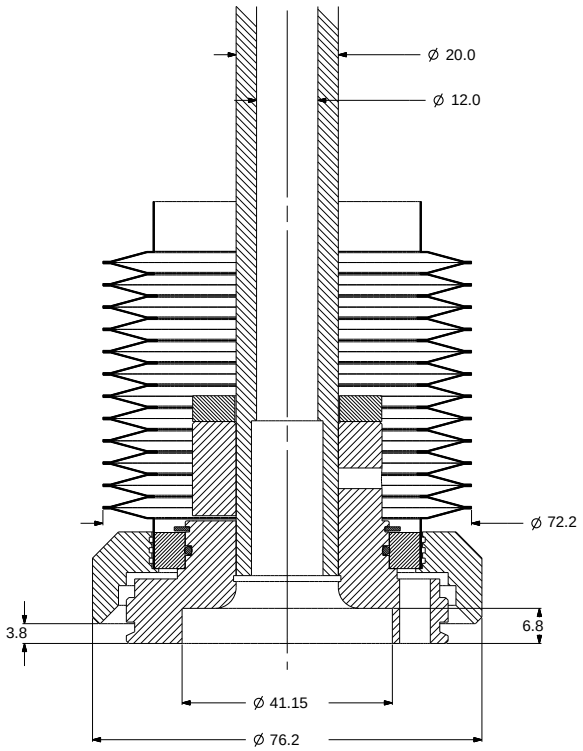


Figure 8-10. Cobra IP-65 Tool Flange

Pressurizing the Robot

The user must supply compressed air to keep a positive airflow pressure in the robot cavity.

1. Remove the red shipping plug from the compressed air fitting on the top of the robot. See the following figure.

Figure 8-11. Compressed Air Fitting on Robot

2. Connect a compressed air source to the air fitting. The specification for the regulated air supply is shown in the following table.

Table 8-1. Compressed Air Specifications

Required Air Pressure	Required Air Flow, Minimum
3 bar, ± 10% (44 PSI, ± 10%)	57 liters per minute (2 cubic feet per minute)

CAUTION: The compressed air supply must be **clean** and **dry** and it must be turned on continuously to maintain a positive air pressure inside the robot. Failure to do this could result in moisture or particle buildup inside the robot and lead to reduced performance or damage to the robot. This will also void your warranty.

8.5 User Connectors

NOTE: DeviceNet and IO Blox are not supported on the ePLC family of Cobra robots.

User Electrical

On the back of the Joint 1 cover, the user electrical connector is filled with a removable plug at the factory. See the following figure. If you use this connector, you must provide a seal (see note below) at the connection to prevent moisture from entering the robot.

> **NOTE:** The user electrical connector (DB-25) on the back of the Joint 1 cover requires a gel seal gasket to maintain an adequate seal. The gasket is supplied in the accessory kit.

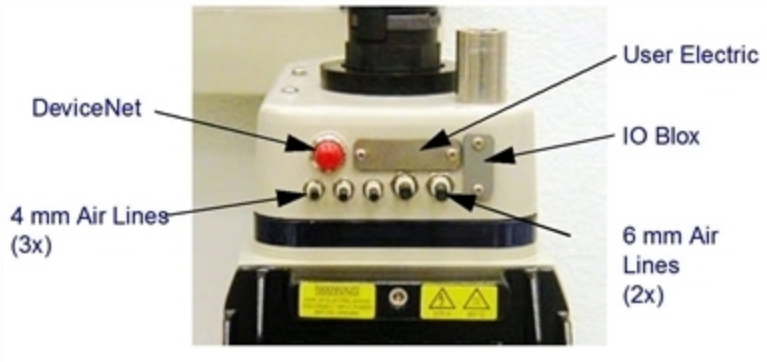


Figure 8-12. User Connectors on Joint 1 Cover

The user electrical connector on the outer link is accessible with the cover removed. See the following figure for the location of the internal connector.

Figure 8-13. IP-65 Internal Connectors with Outer Link Cover Removed

User Air Lines

On the back of the Joint 1 cover, the user air line connectors are fitted with removable plugs at the factory. See Figure 8-12.

The user air line connectors on the outer link are accessible with the cover removed. See Figure 8-13 for locations of the internal connectors.

When routing air lines outside of the robot, any fittings you use must maintain an adequate seal in the cover to prevent moisture from entering the outer link.

CAUTION: Failure to prevent water intrusion through improperly-sealed external fittings could void your warranty.

Robot Solenoid Option

In an IP-65 robot, if you are installing the internally-mounted solenoid hand valves (Adept Option Kit P/N 02853-000), you must use a different air line than described in .

The internal air line normally used to supply the solenoid manifold is instead used to provide positive airflow pressure to the bellows/outer link. You can use one of the passive 6 mm user air lines shown in Figure 8-12 and Figure 8-13.

8.6 Maintenance

IP-65 Bellows Replacement

Check the bellows, Adept P/N 04625-000, periodically for cracks, wear, or damage. Replace bellows, if necessary, using the procedure below.

1. Remove the lower bellows clamp by removing two M3 screws and pulling the clamp apart. See Figure 8-14.
2. Remove the tool flange. For the tool flange removal procedure, refer to Removing and Installing the Tool Flange on page 69.
3. Remove the upper bellows clamp by removing two M3 screws and pulling the clamp apart.
4. Slide the old bellows down off of the quill.
5. Install a new bellows by sliding it up onto the quill.
6. Re-install the upper bellows clamp. You must align mating surface of the clamp half-rings with the bellows seam—see Figure 8-15. Tighten the screw to secure the bellows.
7. Re-install the tool flange.
8. Place new gaskets in the lower bellows clamp—extra gaskets are shipped in the accessory kit. Then install the clamp over the bottom of the bellows, on the bearing ring just above the tool flange. Align the mating surfaces of the clamp half-rings with the bellows seam—see Figure 8-15. Tighten the screw to secure the clamp.

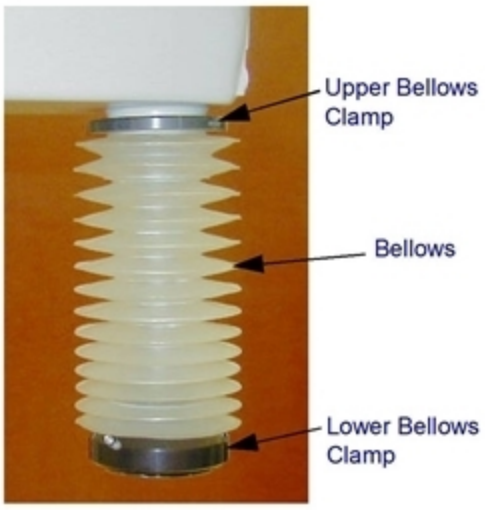


Figure 8-14. Bellows Replacement

NOTE: Align the bellows clamps with the bellows seam, on both upper and lower clamps.

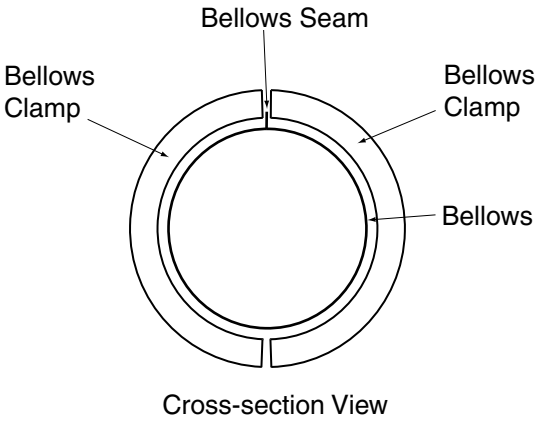


Figure 8-15. Bellows Clamp Alignment

8.7 Dimension Drawing for Cable Seal Assembly

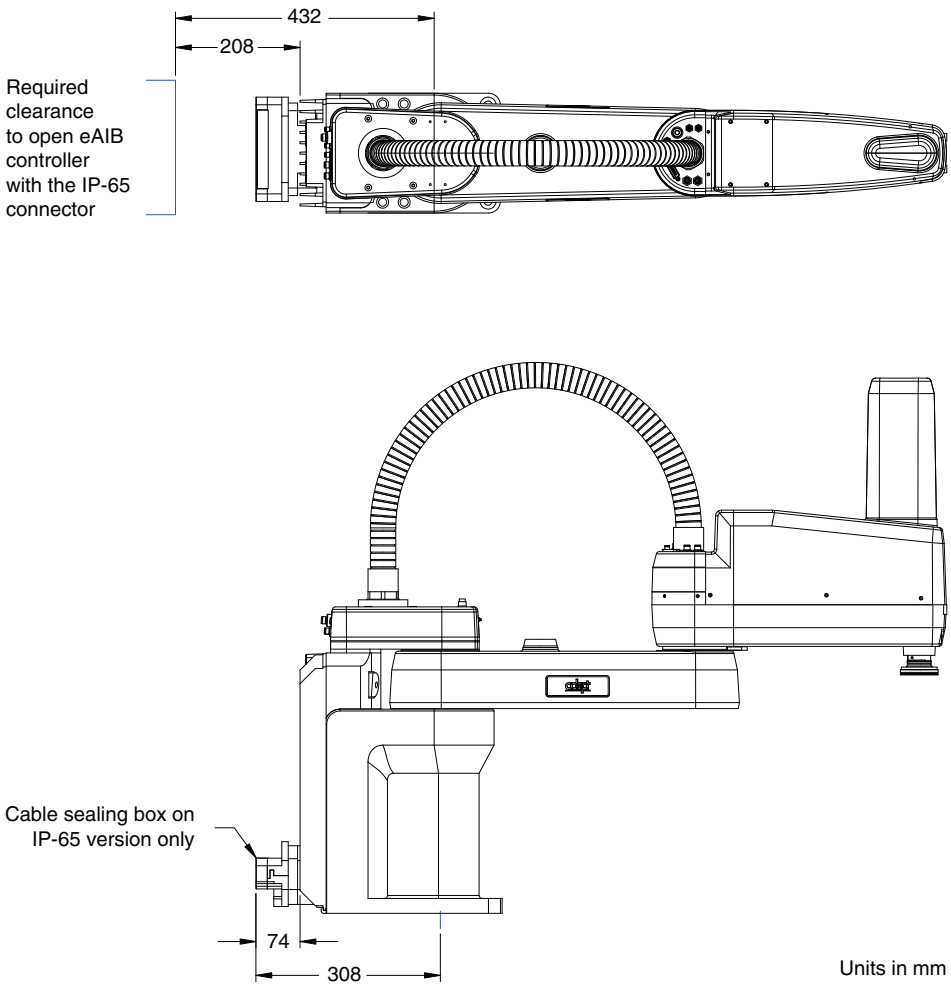


Figure 8-16. Cable Seal Assembly Dimensions

Chapter 9: Cleanroom Robots

The Adept Cobra ePLC robots are available in Class 10 Cleanroom models.

> **NOTE:** Class 1 Limits can be achieved by maintaining the robot speed at Speed 50 or below.

This option is a factory-installed configuration. Changes to the robot include the addition of a bellows assembly mounted at the Joint 3 quill, fully sealed access covers, and a two-stage vacuum system to evacuate the arm. This vacuum system incorporates a compressed air vacuum generator mounted in the base of the robot to provide a high vacuum in the outer link and bellows area. An additional high flow rate vacuum source is required to evacuate in the inner link and base.

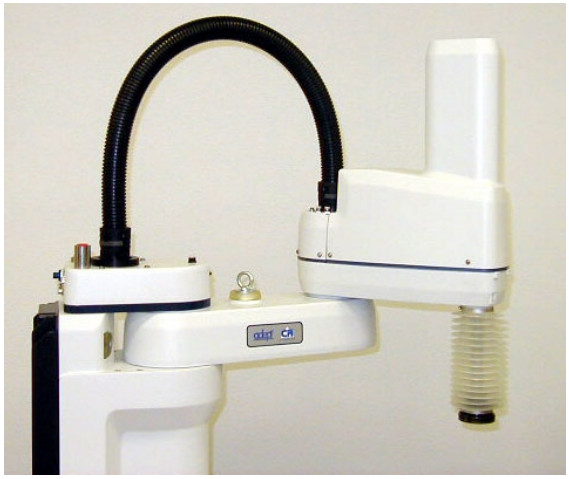


Figure 9-1. Adept Cobra ePLC600 Cleanroom Robot

Cleanroom Specifications

Table 9-1. Adept Cobra Cleanroom Robot Specifications

Robot Performance Specification	See Robot Specifications on page 88.
Ambient Temperature Specification	5 to 35° C (41 to 95° F)

9.1 Connections

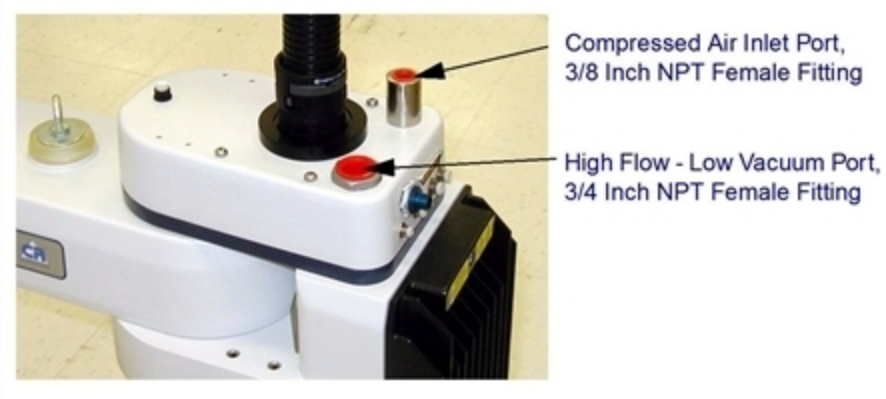


Figure 9-2. Cleanroom Connections

9.2 Requirements

Table 9-2. Cleanroom Robot Requirements

Vacuum source	0.80 m^3/min (28 ft^3/min) minimum volumetric flow rate
	6 mm of water (0.2 inches of water) differential pressure measured between the robot and the vacuum source
	3/4 inch NPT female thread pipe fitting at the back of the robot
Compressed air source	Clean, dry, oil-free compressed air
	75 psi (0.52 MPa)
	1.4 SCFM (.04 m^3/min.) flow rate
	3/8 inch NPT female thread pipe fitting at the back of the robot, flow regulator not supplied
Quill inside diameter	The inside diameter of the quill must be plugged by the user's end-effector in order for sufficient vacuum to develop in the outer link.

9.3 Exclusions and Incompatibilities

Table 9-3. Internally Mounted Hand Valves

Installation considerations	The internal air line normally used to supply the internally-mounted hand valves (Adept Option Kit P/N 02853-000) is instead used to provide vacuum to the bellows/outer link. One of the passive 6 mm user air lines would need to be used instead.
Performance considerations	The air exhausting from the internally-mounted hand valves (Adept Option Kit P/N 02853-000) may be of sufficient quantity/ quality to cause the robot to exceed Class 10 Particulate Limits.
Recommendation	For these reasons, Adept recommends mounting hand valves externally.

9.4 Cleanroom Maintenance

Bellows Replacement

Check the bellows periodically for cracks, wear, or damage. Replace bellows (Adept P/N 04625-000) if necessary, using the procedure below.

1. Remove the lower bellows clamp ring from the bearing ring by loosening the screw on the clamp. See Figure 9-3.
2. Remove the tool flange.

   For the tool flange removal procedure, refer to Removing and Installing the Tool Flange on page 69.
3. Remove the upper bellows clamp ring by loosening the screw on the clamp.
4. Slide the old bellows down off of the quill.
5. Install a new bellows, and reverse the steps listed above.

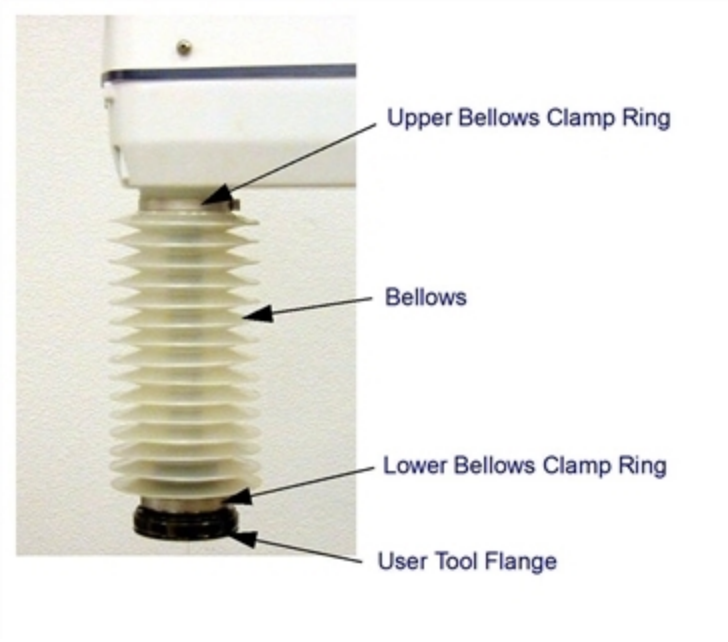


Figure 9-3. Cleanroom Bellows Replacement

Lubrication

The upper and lower quill requires lubrication in the same manner as the standard ePLC Cobra robots. See Lubricating Joint 3 on page 55.

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P/N: 13400-000, Rev A